UNIVERSITY OF EDUCATION, WINNEBA

USING ASTRONOMICAL MODELS TO IMPROVE STUDENTS' ATTITUDES AND ACHIEVEMENTS IN PHYSICS

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SEPTEMBER, 2017

DECLARATION

STUDENT'S DECLARATION

I, Eugene Tetteh-Owusu Okwei, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE:……………………………………

DATE:…………………………………………

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines for the supervision of thesis as laid down by the School of Graduate Studies, University of Education, Winneba.

NAME OF SUPERVISOR: DR. VICTOR ANTWI

SIGNATURE:……………………………………

DATE:…………………………………………

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DEDICATION

I dedicate this thesis to three most important people in my life: my dear wife, Mrs. Salome Nana Adjoa Okwei, my lovely son, Nii Nortey Okwei and my lovely daughter, Naa Odofoley Okwei.

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ABSTRACT

The purpose of the study was to improve students' attitudes and achievements in physics using astronomical models at Komenda College of Education, Central Region. A quasi-experimental design was adopted for the study using the single group pre-test post-test design. Intact class which consists of second year science 2 ''A'' and science 2 ''B'' science students studying elective Physics were used for the study. Forty (40) second year science students studying elective Physics were used. Purposive sampling technique was used for the selection of this class. The instruments used for the study were attitudes towards Physics scale (ATPS), test and interview. The attitudes towards Physics scale (ATPS) was used to measure students attitudes towards Physics. The test and interview was used to examine students' knowledge and ability acquired in Physics concepts and general space science / astronomy concepts. Percentages, mean, standard deviation and independent sample t-test were used to answer the research questions. The results revealed that before the use of the astronomical models students have positive attitudes towards Physics. There was significant difference between the pre-test and post-test which suggests that the use of astronomical models has helped in improving students achievements in Physics. Also after the use of the astronomical models students still have positive attitudes towards Physics. Based on the results obtained it was therefore recommended that teachers must use astronomical models in teaching of astronomy related topics (the universe) in Physics to improve students attitudes and achievements in the Colleges of Education in Ghana.

CHAPTER ONE

INTRODUCTION

Overview

The chapter contains information on the background of the study, statement of the problem, the purpose of the study, educational significance of the study, and the research questions addressed by the study. Also presented are the limitations and delimitations of the study. The chapter ends with the presentation of the operational definitions used in the study as well as a description of the organization of the research report.

Background of the Study

High percentages of college graduates have misconceptions about seasons and phases of the Moon. Research studies have reported that of the effectiveness of instruction aimed at addressing students' ideas about the phases of the Moon, constructivist learning theory is more effective than direct instruction approaches alone (Kavanagh & Agan, 2005). In the study by Schoon (1992), it was pointed out that, "For many students, the manipulation of physical materials, as well as discoveries made for themselves, help in retention of important information".

At stake is an individual's understanding of the Earth-Moon-Sun system. Developing a dynamic mental model that allows an individual to interpret celestial phenomena is intellectually challenging. Direct instruction alone is simply not up to the task of engaging people in using their mental models to find out where they fail or are inconsistent and to construct new models of the Earth, Sun, and Moon in space. According to constructivist learning theory, individuals construct new concepts by modifying their initial ideas in light of new information. Teaching methods based on constructivist theory therefore take into account students' initial ideas and provide new information by engaging them in observations of natural phenomena and in discussions with other students. This allows students to unravel any misconceptions that they may have had in order to construct new and more powerful concepts (Alt, 2015). Constructivist-based activities are generally sequenced so that students clarify and apply their current mental models to new situations and encounter information or ideas that challenge any erroneous beliefs that they may hold. A constructivist approach may be considered a relatively inefficient method of instruction in that it generally takes quite a bit of class time to conduct activities and for students to discuss their own ideas, but it is thought to be more effective than a direct instruction approach in encouraging students to modify their current mental models to accommodate new information or ideas (Franco & Colinaux, 2000).

Trundle, Atwood, and Christopher (2007) pioneers in the study of conceptual understanding, interviewed children to determine what they understood about the Moon. They found that children held non-scientific, or alternative, conceptions about the apparent movement of the Moon across the sky and about the cause of moon phases. Elementary students' understandings about the Moon have been the focus of more recent studies (Broadstock, 1992; Stahly, Krockover, & Shepardson, 1999) that support Piaget's earlier findings. Broadstock (1992) interviewed 13 students in Grades 1-5 and found that a majority of her sample held alternative conceptions about the cause of moon phases. She found the most common alternative conception to be that moon phases are caused by the Earth's shadow. This perspective is often called the eclipse model. Results from other studies that included children (Baxter, 1989; Barnett & Moran, 2002; Schoon, 1988) are consistent with these findings. Interestingly, several researchers who conducted cross-age studies and studies of college students obtained results very similar to findings with elementary students (Baxter, 1989; Bisard, Aron, Francek, & Nelson, 1994; Schoon, 1988). These results clearly indicate the pervasiveness of a conceptual understanding problem on the cause of moon phases across a wide range of ages and grade levels. Furthermore, from elementary school through college levels the eclipse model has been found to be the most commonly held non-scientific, or alternative, conception (Trundle, Atwood & Christopher (2002). During the past two decades there has been a growing interest in student understanding of scientific concepts and how their conceptions can be used to design instructional interventions (Baxter 1989; Driver & Oldham, 1986; Vosniadou, 1991) cited in Barnett & Morran (2002). In analyzing the results of these interventions, several researchers have concluded that these alternative frameworks are resistant to change. In response to these and other findings, educational researchers have focused on developing instructional strategies that directly address alternative frameworks during instruction. By directly addressing alternative frameworks researchers believe that students will be forced into a state of cognitive conflict and recognize the inadequacies of their prior understanding and replace their incorrect concept(s) with the correct scientific perspective(s) (Gilbert & Watts, 1983). However, in recent years this replacement view of conceptual change has been challenged. That is, there is a growing body of literature which claims that instructional interventions designed to directly confront students' alternative frameworks may not be very successful in accomplishing conceptual change. Nussbaum and Novick (1985), and Vosniadou (1991) cited in Barnett & Morran

(2002) showed that students' understanding of gravity was closely tied to their understanding of the shape of the Earth. These studies suggest that the concepts of a spherical Earth, space, and gravity were closely connected. That is, students find it difficult to understand that gravity is directed toward the centre of the Earth if they do not understand that the Earth is spherical. Further, if students are to develop an understanding of the reasons for the phases of the Moon, they first should understand the concept of how light reflects and that the Moon shines by reflecting light from the Sun (Vosniadou (1991) cited in Barnett & Morran, 2002). It has also been speculated that students may not be able to articulate understandings of the above astronomical phenomenon before they have a reasonable understanding of the relative size, motion, and distances between the Sun, the Moon, and the Earth (Treagust &Smith, 1989; Vosniadou (1991) cited in Barnett & Morran, 2002). In other words, it is important for the teacher to consider what concepts are precursors for understanding more complex concepts rather than just selecting important astronomical concepts to teach (Ahlgren cited in Barnett and Morran, 2002).

Statement of the Problem

Physics can be recognised as an important academic subject to every society. The reason for this is due to the fundamental role it plays in modern scientific and technological developments. Despite this, students' performance in the subject at the national and internal examinations has been relatively low (Chief Examiner's Report CoE, (2013-2015); Chief Examiners' Report [WAEC](2006), (2012); Anamuah-Mensah, Mereku & Ampiah [TIMSS 2007 Ghana Report] (2009).

Some physics concepts and theories are perceived to be abstract and therefore appear difficult for students to comprehend e.g. the study of the universe. This perception might be a contributing factor to students' low performance and attitude towards the subject (Agina-Obu, 2005; Trumper, 2003).

However, studies show that the use of astronomical models has the potential to improve upon students' performance and attitude in Physics (Vosniadou, Ioannides, Dimitrakopoulou & Papademetriou (2001).This informed the researcher to use astronomical models to improve students' attitudes and performance in physics

Purpose of the Study

The purpose of the study is to specifically improve students' attitudes and achievements in Physics using astronomical models at Komenda College of Education in the Central Region of Ghana.

Objectives

The following objectives were formulated to guide the study:

1. To find out the attitude of Colleges of Education students towards Physics before the introduction of astronomical models in teaching.
2. To determine the effect of astronomical models on students' achievements in Physics.
3. To determine the effect of astronomical models on students' attitudes in Physics after the introduction of astronomical models in teaching.

Research Questions

The following research questions were posed to guide the study:

1. What attitudes do Colleges of Education students have towards Physics before the introduction of astronomical models in teaching?

2. What is the effect of astronomical models on student's achievements in Physics?
3. What is the effect of astronomical models on student's attitudes in Physics after the introduction of astronomical models in teaching?

Significance of the Study

Physics is one of the major requirements for admission to some higher institutions of learning. Its effective teaching helps not only Physics students but the non-Physics students as well. The findings of this study when made available to teachers, the methods and approaches towards the teaching and studying of the subject will improve and be put in the right perspective.

The findings of this study will have both theoretical and practical benefits to the future of Physics education and development in Ghana. The study is expected to contribute to the improvement of knowledge and skills needed for effective Physics education. The study may lead to improved strategies in teaching and conducting practical Physics lessons not only in Ghana but also in other parts of the world. The research seeks to bring to the doorsteps of policy makers, curriculum developers, implementing bodies and other stakeholders the actual situation on the ground so that they can have a fair assessment and judgment of the impact of the conduct of effective practical Physics lessons. The study may also be of immediate benefit to the Ministry of Education (MOE) and other educational stakeholders in the formulation of future Physics education policies aimed at enhancing students' achievements in Physics. This would help authorities come out with pragmatic measures to address this shortcoming. This study would guide teachers in helping students to develop positive attitudes and achievements in the learning of practical Physics.

Lastly, this research will serve as a document or a reference material for those who will like to do further research in using astronomical models.

Delimitations of the Study

The study was conducted in the Komenda / Edina / Eguafo / Abrem municipal assembly in the Central Region of Ghana, specifically in Komenda College of Education and this College was used for the data collection. The scope of the study was focused on all second year science students in Komenda College of Education. According to Simon and Goes (2011), the delimitation of the study are those characteristics that arise from limitations in the scope of the study. Delimitation defines the boundaries and by the conscious exclusionary and inclusionary decisions made during the development of the study plan. Examples of these exclusionary and inclusionary decisions are the choice of objectives and research question(s), variables of interest, the choice of theoretical perspectives that will be used, the methodology, and the choice of participants. Hence, there are many methods of teaching physics, but for the purpose and direction of this research, the use of astronomical models in teaching Physics was selected for the study. The study was also restricted only to second year science students reading elective Physics because the astronomy topics under consideration are in their Physics course outline. Lastly, the topics considered are under astronomy topics, just an aspect of the entire Physics topics at the CoE.

Limitations of the Study

The limitations of the study include the possibilities of the students in the class interacting with each other outside the classroom which could affect the results of the study. Also, the researcher being the interviewer could serve as an impediment to the study because students might not say the truth.

Due to time and financial constraints, the study was restricted to only second year science students in Komenda College of Education in the Central Region. Other limitation of the study was absenteeism on the part of the students. Some research participants were absent from school due to truancy. All these hindrances were beyond the reach of the researcher. All of the above limitations served as obstructions to a very detailed study. The results could therefore not be generalized to all Colleges of Education, all courses or subjects.

Operational Definition of Terms

For better understanding of this research work, the following terms were defined in order to reduce ambiguities.

(a) **SCIENCE STUDENTS**: Refers to students who are registered in the Department of Sciences in the Colleges of Education to read elective subjects like Physics, Biology, Chemistry and Mathematics and will be awarded Diploma in Basic Education (DBE) certificate after successful completion for a period of three years.

(b) **COLLEGES OF EDUCATION (CoE)**: This refers to the teacher training colleges of formal education in the Ghana school system. It covers a period of three years. Post secondary institutions established to train professional teachers to teach at the basic schools in Ghana.

(c) **DIPLOMA IN BASIC EDUCATION (DBE)**: This refers to the certificate awarded to students in the Colleges of Education after successful completion of their three years programme.

(d) **MODELS**: In a general sense, a model is a representation of a phenomenon, an object, or idea. In science, a model is the outcome of representing an object, phenomenon or idea (the target) with a more familiar one (the source).

(e)**ASTRONOMICAL MODELS:** Models used in astronomy to teach astronomy topics in schools, colleges and the universities.

Organisation of the Study

This research report is presented on five chapters. Chapter one entitled introduction comprises of background and general concepts of the study, statement of the problem, purpose of the study and objectives, research questions, significance of the study, limitations, delimitations and the organisation of the study.

Chapter two, entitled Literature Review deals with what has already been written about the topic in terms of theories and empirical evidence. The review is geared towards justifying the defined objectives of the research and establishing the premise / theoretical framework for the research work. It also identifies the gaps in the literature in which the study attempts to fulfill. It shall also cover the overall goal of clarifying how the present study intends to address the gap. In addition, it covers the summary of major findings of the literature review.

Chapter three, entitled Research Methodology, provides information on participants, the research design including sampling techniques, procedures (including evidence of ethical considerations), and equipment used in both data collection, and analysis. It also deals with the research design employed, the population and sample selected, the research instruments used, description and distribution of instruments. It also covers the intervention process that is, the pre-test, the intervention and the post-test.

Chapter four headed Results / Findings and Discussions deals with the outcome of the research presented and explained. The findings are presented in tables, charts and figures. The discussion deals with significant and novel findings identified, interpreted and discussed. It also highlights the major findings of the research and the inferences made from them in view of findings from related previous studies.

Chapter five entitled Summary of Findings, Conclusions and Recommendations, deals with itemizing the major research findings, and indicate how the research work has contributed to knowledge. It also includes conclusions, recommendations and suggestions for further study or research work.

CHAPTER TWO

LITERATURE REVIEW

Overview

The chapter of the study presents the views of various authorities on the subject matter under study. The chapter provides a broad critical view of the various empirical and theoretical ideas and perspectives on the study. It tries to review, compare and contrast the ideas of the various authors concerning the chosen topic. This will fairly and rationally broaden the horizon of the researcher and those who will read the end product.

The literature review covered two main aspects and these are the theoretical framework and empirical framework. The theoretical framework discusses the need for practical activities such as the use of astronomical models in teaching general space science / astronomy concepts in Physics which transcends the boundaries of other methods of teaching especially the lecture method. Just after the theoretical framework, we have the empirical framework which has been discussed.

Theoretical Framework

The theoretical base of this study is embedded in the constructivists' theory of learning.

Constructivism

Generally, constructivism "demands active participation and shifts responsibility from teachers to learners … the approach allows learners to form their own representations of knowledge as well as take more responsibility for their own learning" (Keengwe, Onchwari & Agamba, 2014, p. 893). Karagiorgi and Symeou (2005, p.18) further explain that "non radical or social or moderate constructivists…believe that shared reality grows out of social constraints placed on the constructive process of the individual". Both founders of constructivism and those who followed value this role of culture, context, and socialization in learning (Carter, 2008), an increasingly important component of education in globalized institutions. It may seem advantageous to use purely constructivist methods to achieve course outcomes, but Boghossian (2006) points out that, under this philosophy, "helping students arrive at the truth is impossible, and therefore it cannot be the purpose of education. Constructivist learning theory is about the process of learning and helping people discover their truths". More radical forms of constructivism imply that whatever students believe must be the real truth or reality (Boghossian, 2006; Karagiorgi & Symeou, 2005), even if it is in conflict with agreed-upon truths that exist, for example, in the form of content objectives. Because of the impracticalities of these more radical interpretations of constructivism, such as the impossibility of evaluating objective industry standards in a skilled trades program, it is important to revisit a practical and realistic definition of constructivism. Golding (2011) describes a spectrum of teaching methods with constructivism on one end and purely transmissive methods on the other; educators may be able to balance between the two as in the case of having students explore a course outcome from different perspectives. Kotzee (2010) points out that constructivism is a philosophy of knowledge, not pedagogy, and is unrealistic to use as an effective teaching method in its more radical forms. Kotzee (2010) argues against using pure constructivism as a pedagogy, contending that "if all opinions are indeed deemed equally valid, students are left entirely free to hold a range of opinions that work against the very possibility of educating them",(p.180) and that a wide range of acceptable truths negates a teacher's ability to declare answers incorrect on assessments. In short, Kotzee (2010) effectively argues that while an educator can hold constructivist philosophies about the nature of knowledge, in order to teach, one must believe to some degree in objective truths. Echoing Kotzee's (2010) ideas, this research work sees the value of using the terms *pragmatic or moderate* constructivism (Karagiorgi & Symeou, 2005) and *constructivist realism* (Cupchik, 2001) which blends positivism with social interactions in a way that leads to more practical educational applications of constructivist principles. In fact, pragmatic constructivism aligns with the "explicitly employment-led mandate" (Randall, McQuay & Blanco, 2010, p. 7) of colleges, with the purpose of helping students find and maintain jobs in an evolving workplace. There is strong evidence that these pragmatic constructivist teaching methods are well suited for college demographics, especially for the large cohort of students born between 1982-2002, the Millennial Generation, who expect more student-centred teaching methods (Carter, 2008). Carter (2008) describes how technology has facilitated collaboration in this large cohort and cites multiple sources that suggest millennial value diversity, human connection, and the importance of having a positive impact on others. These values are reflected in constructivist learning environments where expertise and perspective is collected from every member of the class instead of being centred with the instructor (Carter, 2008).

Alt (2015) notes that this type of genuine care and concern in a classroom increases adults' academic outcomes and abilities. Mature, first-generation, international, and neurologically diverse students, for example, would all benefit from sharing their own experiences and learning from others. It is clear that using *cognitive* constructivist instruction provides a rich context for students to explore multiple pathways to "learn how to learn" by using their higher order thinking skills (Keengwe, Onchwari & Agamba,2014, p. 889).

Hains and Smith (2012, p. 370) state that "educators involved in student centred classes need to be comfortable with a reasonable amount of ambiguity and flexibility" a skill which takes time and effort to develop over an educator's career. However, the extensive paperwork and reviews required by quality assurance initiatives leave very little time for instructors to do anything else, including training on new standards (Keil & Haughton, 2007) or developing their practice. This is especially true during transitional phases leading to more intensive accountability standards and considering that constructivist teaching methods may require more instructor preparation or more time than a 16 weeks college term allows. Recent education reform requires teachers to depart from the traditional practice of knowledge transmission to constructivist teaching where students are encouraged to construct knowledge through inquiry (Beck, Czerniak & Lumpe, 2000; Levitt, 2002). Constructivist classrooms allow students to actively participate in the learning activities to construct their knowledge thus, keep them engaged during a longer period of time (Schraw, Flowerday & Lehman, 2000; Schraw & Lehman, 2001). Since knowledge construction requires connection with prior knowledge, constructivist teaching draws on students' prior knowledge and experiences (Driscoll, 2005).

In general terms, constructivism helps students to discover knowledge through active participation (Schraw, Flowerday & Lehman, 2001; Schraw & Lehman, 2001), triggering prior knowledge (Driscoll, 2005) and high-level questioning (Erdogan & Campbell, 2008). Teacher education programs should include frequent opportunities of constructivist teaching experiences for pre-service teachers in order for them to gain content and pedagogical skills (Haney & McArthur, 2002). Despite the reform efforts that advocate student-centred constructivist teaching, teachers still heavily rely on more traditional pedagogies, such as lecturing, drill and practice at all levels of schooling (Berberoglu, 2010: Fischer-Mueller & Zeidler, 2002; Uğurel, Bukova-Güzel & Kula, 2010). Some teachers are unable or unwilling to modify their practices that align with recent reform initiatives (Davis, 2003) that encourage active participation of students, inquiry, discovery, and critical thinking (National Academy of Sciences, 2006). Though more positive, pre-service teachers too, have difficulty in implementing constructivist teaching strategies. They show reasons such as lack of knowledge, large class sizes and inadequate school facilities for this phenomenon (Uzuntiryaki, Boz, Kirbulut & Bektas, 2010). Bandura (1997) argues that teachers' preference of either traditional or constructivist teaching was affected by several factors such as experiences of university teacher education, past school experiences, out-of-school experiences, and personal beliefs. Levitt (2002) stated teachers may be convinced about the value of student-centred constructivist activities but they may not able to deliver the activities successfully. They tend to rely on textbook where teacher questions mostly focus on factual information (Levitt, 2002).

The current teacher-centred educational practices might be favouring certain learning styles, while they neglect others (JilardiDamavandi, Mahyuddin, Elias, Daud & Shabani, 2011; Kablan &Kaya, 2013). Some researchers argue that traditional methods such as lecturing serve to abstract learning (Jones, Reichard & Mokhtari, 2003). They prefer reading, lectures and exploring models in formal learning settings (Arthurs, 2007). Assimilators are more interested in abstract concepts and putting information in a logical form (Jones, Reichard & Mokhtari, 2003; Kolb & Kolb, 2005b). Individuals who utilize abstract conceptualization and active experimentation are called convergers. Convergers prefer experimenting, simulations and laboratory assignments (Kolb & Kolb, 2005a). Learners with a diverging style have reflective observation as well as concrete experience dominant learning modes. They are interested in observing and gathering a wide range of information; they are good at generating ideas (Healey & Jenkins, 2000; Jones et al, 2003). Individuals with an accommodating learning style have concrete experience and active experimentation as their dominant learning modes. Learners in this style are interested in 'hands on' experience (Healey & Jenkins, 2000;Jones et al, 2003). They rely on their feelings rather than logical analysis when it comes to problem solving. They prefer working in groups, doing field work, having new and challenging experiences, and testing different approaches in completing a project.

Jones and Steve (2007) argue that the lecture remains an effective teaching method but emphasizes the importance of student engagement, suggesting the implementation of in-class games and other activities to enhance learning. Jones and Steve (2007) say such an approach should emphasize student reflection on information, just as constructivists suggest.

Elements of Constructivist Teaching

Baviskar, Hartle, and Whitney (2009) outline how constructivist approaches can be effective in any number of teaching styles, including lectures, but that even activity-based courses must meet certain criteria. Zaitoon (2007) refers to constructivism as a process of receiving which involves learners' building of new meanings within the context of the current knowledge according to their experiences and learning environment. It was one of the most important revolutionary theories in the field of education, as it focused on the knowledge and how to provide it to learners in gradual steps, and it receives growing interest in contemporary educational thought, Aqeeli (2005) stresses its importance as a new theory in teaching and learning based on the idea of teaching for understanding, and the adoption of the learner as the centre of the educational process; the constructivist teaching is based on the principle that the learner is active and positive.

Constructivism theory is based on three bases as Khataibeh (2008) demonstrates:

1) The meaning is self-built by the cognitive mechanism of the learner, and the (meaning) is not transfered from the teacher to the learner, but created inside the mind of the learner as a result of interaction with the outside world, and definitely influenced by previous experiences.

2) The formation of meanings is a psychological process requires active mental effort.

3) The cognitive structure of the learner is resistant to change.

In the light of constructivism theory, the teaching shifts from focusing on external factors to focusing on internal factors that affect learning, such as prior knowledge of the learner, the ability to remember and processing of information, and motivation to learn, and this makes learning meaningful. Zaitoon (2003) indicates that learning in this theory is an ongoing process of building, which is active and purposeful. A structural process means that the learner makes new structures of knowledge or rebuilds compositions or his cognitive system, since the experience of the learner, and prior knowledge have a clear impact on the learning process. Therefore, every learner has his own way of understanding, as the learning process is not conveyed or copied from the mind of the teacher to the learner’s, but must be based on understanding of a meaning. In any process of learning and teaching, it would be essential that the teacher reaches a common understanding with the learner; which means that the learning processes should include negotiation and interpretation to reach this understanding. Being an active process means the learner is making mental effort to gain access to knowledge for himself, and being a purposeful process means that learner seeks to achieve certain purposes which contributes to solving the problem he faces, answer a question, or satisfy internal tendency, and this underlines the importance of taking the purposes of learning from the learner's a real life, interests and needs. The assumptions below underlie the theory, In general are:

1) Learner is active during the learning process, and this active process leads to the formation of the meaning.

2) Prior knowledge of the learner is the focus of attention in the learning process, as he builds knowledge on the light of previous experience.

3) The learning process includes the construction of new meanings or rebuilding and modification of meaning through social negotiation with others.

4) Learning is influenced by previous knowledge.

5) Teaching methods that allow the exchange of views and ideas help to explain the phenomena.

6) Investigative activities are helpful when they encourage discussion.

7) Learning cannot occur without a change in the cognitive structure of the learner, as the re-organization of knowledge happens after receiving new knowledge.

8) The best learning occurs when the learner is facing new situations, new tasks and problems.

9) Learner builds knowledge through social negotiation process (Glaserfeld, 2001, p.130; Zaitoon, 2003, p.142).

Many models have emerged from the constructivism theory, including: conceptual change model, learning cycle model, problem-based learning model, generative model, constructivist learning model, and others, all of these models allow the learner active participation in activities to build and organize the knowledge by himself (Mazen, 2009).

The Constructivist Learning Model focuses on the learner as a centre for the learning process, able to build knowledge by himself through the collection of information and data, the formation of hypotheses, access to results and generalizations, discuss solutions, ideas and concepts, and develop them through interaction with others, then apply the findings in new educational conditions and situations.

Steps of the Constructivist Learning Model

Zaitoon (2007) indicated that constructivist learning is made up of four complementary stages, which adopted the constructivism theory to ease learner's construction of scientific concepts through mental processes, and each stage is closely linked to the next stage and the stages are:

1-Engagement or Invitation Stage

At the beginning of the educational situation, the teacher engages the learners in the new subject asks them questions in order to invite them to learn, think, motivate them, and create a knowledge-based environment to learn the subject, and figures out their ideas and knowledge necessary to learn a new subject.

2-Exploration Stage

This stage is the most important in the classroom, where the teacher divides the learners into heterogeneous groups; and each group carries out various activities such as collecting data and information, classifying them, develop hypotheses, ask questions, search for answers and explanations, access to solutions, criticize them, issue judgment; in preparation for social dialogue to reach solutions to the question raised at the beginning of the class. The teacher here is a facilitator hears and raises additional questions.

3-Explanation Stage

At this stage learners provide explanations, suggestions, propose solutions, and test the validity of these solutions based on their new experiences, as they build the new knowledge and link it to the previous one, or modify the previous knowledge and perceptions, and the teacher has to encourage learners to formulate their findings, give them enough time to put forward suggestions and interpretations, help learners, and facilitate the learning process.

4-Decision Making Stage (Problem Solving):

This step involves access to the appropriate solution to the problem and implementation of such solution. Hence the cognitive integration process occurs between the new and previous concepts, which lead to cognitive integration of the concepts and the emergence of more extensive and deeper concepts. Consequently, this resulted in new construction of knowledge at the part of the learners, and application of what they have learned in new situations.

The scientific thinking is considered a complex mental process through which the learner can do meaningful thing based on the situations he passes through, Jarwan (2005) refers to it as a mode of thinking that supports the scientific method. However, Zaitoon (2014) refers to it as that mental activity used by the individual to address the problems he faces in his life, and to search, explore problems and find solutions. Attention to scientific thinking has begun because of close relation to scientific and technical development, and reflected on the scientific education that targets the development of inquiry skills and scientific study of learners.

The contemporary educational trends emphasize the need for scientific thinking development, as the main report of the US National Science Council stressed the need to develop the learner's capabilities (Qadri, 2005). In Jordan, the Education Act indicates that the main goals of education are the development of thinking skills among students; in order to create the ideal citizen (Ministry of Education, 2012).

Those interested in science teaching believe that helping students to acquire various scientific thinking skills such as: observation, classification, measurement, conclusion, forecasting, judging, induction, inference, interpretation of data, control of variables, etc., and that practice and application of these skills is one of the fundamental objectives of the scientific education, when acquired by the students, it helps them to cope with renewable life problems, and it should be noted that the advanced industrial countries attention to this goal in their educational programs was a critical factor that helped them to achieve scientific and technological advancement (AbuJalala, 2005).

The Scientific thinking has many features:

1) It is an organized process passing through specific steps beginning with the purposeful note of the phenomenon, and ending with an explanation in the form of hypotheses validated by experiment.

2) A purposeful process with a specific and clear goal.

3) Does not occur in isolation from human, rather, it is a product of mental activity.

Dewey identified the elements of scientific thinking as follows: identify the problem, collect data, develop hypotheses and test their validity, choose the most suitable ones and solve them. Thus, scientific thinking is a mental activity essential in regulating the individual ideas and solves problems facing him in an objective manner, and helps individuals take the decisions that have become one of the main goals of scientific education at the present time (Qadri, 2005). Educators paid attention to the academic achievement, because of its great importance in the learner's life, it is the result of what happens in the educational institutions of multiple learning and teaching activities resulted from skills, knowledge, trends, tendencies and processes of science, AbuJado (2003) identifies it as the outcome of what you learn after a period of time, measured by planned tests, According to Jalali (2011) it is the learner's achievement of the highest level of science or knowledge to move from one stage to another for science and knowledge.

Academic achievement was subject of multiple study and studies as efforts tended to look for factors and mental, emotional, and social variables associated with the study achievement - as Multi-Variable Phenomenon – starting from the school and its possibilities, the teacher and the skills and methods of teaching, curriculum, the learner's abilities, trends, and motivation.

Accordingly, the use of Constructivist Learning Model in the teaching of science can contribute to the improvement of student achievement, and the development of their scientific thinking. This study came to investigate the effect of astronomical Models in student achievements, and their attitudes in Physics.

The purpose of using astronomical models as in teaching and learning materials fits into the ideas of constructivism. This is because it excites and sustains the interest of learners, ensures practical work, enables learners to acquire skills and promotes acquisition of first hand information.

Empirical Framework

Narmadha and Chamundeswari (2013) investigated attitude towards learning Science and Science achievement among secondary school students from different types of schools in the city of Chennai, India. The attitude towards Learning of Science Scale was used to assess the attitude towards learning science and the marks scored in science were taken from their half yearly performance. The girls were found to be better in their attitude towards learning of Science when compared to the boys in all categories of schools. Fatoba and Aladejana (2014) in their study examined the gender on students' attitude in Physics in senior secondary schools in Oyo State, Nigeria. The participants for this study were 160 senior secondary school two (SSS2) students offering Physics in Ibadan, Oyo State. It was found that there was a slight difference in attitude among the students in favour of females in Physics. Shaw (2003) cited in Veloo, Nor and Khalid (2015) in his study identified the relationship between students' attitude towards Physics with their achievements in Physics. The finding showed that there is a relationship between attitude and achievement for female students but not for male students. The result showed that there is no difference in attitude between male and female students towards Physics. A study by Lena (2005) showed that male and female students who achieved high grades in Mathematics do not differ in terms of their attitudes towards Mathematics. For Physics, female students who showed positive attitude obtained better results compared to male students. A study by Visser (2007) found that students' attitude towards Science, especially the female students, decreased when they entered secondary schools. The female students' attitude towards Physics was found to be low and they commented that learning Biology was more enjoyable. A study by Nur Asyiqin (2004) showed that there is a difference in terms of attitude dimension between male and female students.

The findings in the study by Pell and Manganye (2007) showed that there is no difference between attitude and gender among African students. However, in a study by Pell and Jarvis (2001) found that male students recorded a much higher positive attitude compared to female students. Male students, consistently, have a more positive attitude towards Science compares to female students. This situation is prominent in Physics compared to in Biology (Visser, 2007). Kessels, Rau, and Hannover (2006) found that female students lack interest in Physics compared to male students. Female students have a higher negative attitude towards Physics compared to male students. Female students claimed that Physics is difficult for them because the subject tends to favour the masculine nature. According to Marsh and Tapis (2002), the difference in students' attitude in terms of gender will result in difference in achievement and readiness to achieve learning target. Based on the study done by Johnson (1987), Physics and Mathematics are said to be in contrast to the female natural being that are known to have feminine characteristics. Male students showed more positive attitude towards subjects that are considered as masculine compared to female students who are more positive towards subjects which are more feminine such as Biology. A study by Sgoutas, Nagel, and Scott (2005) conducted on 148 science students in San Diego found that female students have a higher negative attitude compared to male students.

Related studies

Diakidoy and Kendeou (2001) cited in Trumper (2006) reported a study they carried out with fifth-grade students learning astronomy concepts such as the Earth's shape and rotational movement, and the day-night cycle. Their findings showed that students who received experimental constructivist instruction in the targeted astronomy concepts demonstrated significant improvement in their understanding and learning of these concepts, in contrast to students who received standard, textbook-based instruction. Bakas and Mikropoulos (2003) cited in Trumper (2006) developed an educational tool based on the technologies of Virtual Reality. The objective was to create an interactive three-dimensional artificial learning environment within which students were able to come into immediate contact with the movements of the planets and the Sun and the phenomena occurring in our solar system, in particular the Earth-Sun system. The purpose was also to provide students with environments that gave them the opportunity to experience cognitive conflict and to reject possible misunderstandings engendered by them. Findings showed that after the interaction with the virtual environment, students aged 12–13 created fewer, more concrete and scientifically accepted mental models. Trumper (2006) reported significant positive outcomes from a teaching package in astronomy education based on what they called

Mental Model-building Strategy. In the research, junior high school students were given the opportunity to generate, critique and successively refine their mental astronomy models of the Sun-Earth- Moon system.

Suzuki (2003) cited in Trumper (2006) described a very interesting and effective conversation-based strategy for teaching about the Moon. He documented students' ideas, and reconstructed them in two research seminars in science education for university students training to be elementary and junior high school teachers.

What is a model?

In a general sense, a model is a representation of a phenomenon, an object, or idea Gilbert (2000) cited in Ornek (2008). In science, a model is the outcome of representing an object, phenomenon or idea (the target) with a more familiar one (the source) Tregidgo & Ratcliffe (2000) cited in Ornek (2008). For example, one model of the structure of an atom (target) is the arrangement of planets orbiting the Sun (source) (Tregidgo & Ratcliffe, 2000). The model can only relate to some properties of the target. Some aspects of the target must be excluded from the model (Driel & Verloop, 1999). For example, the solar system model of the atom models the nucleus surrounded by electrons but excludes the delocalization of electrons, among other aspects. With respect to Physics, Hestenes (1996) describes a model as a representation of structure in a physical system and/or its properties. The system may consist of one or more material objects. A model refers to an individual system, though that individual may be an exemplar for a whole class of similar things.

Categories of Models in this research, the researcher will discuss mental models, conceptual models, and Physics models respectively. Conceptual models are mathematical models, computer models, and physical models. Mental models are psychological representations of real or imaginary situations. They occur in a person's mind as that person perceives and conceptualizes the situations happening in the world (Franco & Colinvaux, 2000), Norman cited in Ornek (2008) indicates that mental models are related to what people have in their heads and what guides them using these things in their minds. In order to understand mental models, their characteristics should be considered. Mental models have a variety of features (Franco & Colinvaux, 2000) cited in Ornek (2008). These are:

1. Mental models are generative.
2. Mental models involve tacit knowledge.
3. Mental models are synthetic
4. Mental models are restricted by world-view.

Conceptual Models

A conceptual model is an external representation created by teachers, or scientists that facilitates the comprehension or the teaching of systems or states of affairs in the world (Greca & Moreire, 2000). According to Norman (1983), conceptual models are external representations that are shared by a given community, and have their coherence with the scientific knowledge of that community. These external representations can be mathematical formulations, analogies, graphs, or material objects. An example of an object could be a water pump which is sometimes used to model a battery in an electric circuit. An analogy can be established between an atom and the solar system. The ideal gas model is a mathematical formulation (Greca & Moreire, 2000). To come to the point, we can say that conceptual models are simplified and idealized representations of real objects, phenomena, or situations.

Further, quantitative and qualitative evidence has been reported for positive effects of model-based pedagogies on science learning across different subject areas and grade levels (e.g. Gobert & Clement, 1999; Gobert & Pallant, 2004; Khan, 2007; Rotbain, Marbach-Ad, & Stavy, 2006; Schwarz & Gwekwerere, 2007; Schwarz & White, 2005). However, the term 'representation' is commonly used to explain what a model is. Gilbert and Ireton (2003, p. 1) suggested, for example, 'a model is a system of objects or symbols that represents some aspect of another system'. Also, Windschitl and Thompson (2006, p. 784) viewed models as representations of how some aspect of the world works, and Schwarz and Gwekwerere (2007, p. 160) defined scientific models as representations that embody portions of scientific theories. Simply speaking, a model is something that represents something else. A miniature volcano represents a real volcanic mountain, and the Big Bang model in astronomy represents an idea about the birth of the universe. In the context of science education, the term 'mental model' is frequently used, denoting a form of mental representation that may preserve the structure of the thing it represents (Vosniadou, 2002). But models do not only represent real world systems by the process of mirroring or mimicking nature (Koponen & Mantyla, 2007). Rather, scientific models can be created in novel ways to express abstract ideas and include theoretical entities. For example, Giere (1999b) argues that Newton's gravitational law should be understood as a theoretical model since it defines idealized objects, for example, mass point and centre of mass, and is not perfectly similar to a real-world system. The thing represented through a model is often called a 'target' or 'referent'. A model, however, need not represent everything of a target because representation does not merely mean resemblance. Suarez (1999, p. 77-81) asserts that 'resemblance is neither sufficient nor necessary for representation' and that 'a model is typically representational because it is intended for a particular phenomenon or type of system'. A model represents specific aspects of a target which are selected by a modeler with a certain purpose. In this regard, Halloun (2004) viewed a model as a partial representation of a specific pattern in the real world. Based on the discussion thus far, a model can be defined as a representation of objects, phenomena, processes, ideas and/or their systems (Gilbert & Boulter, 2000, p. vii). This definition is exclusive enough to prevent what indicates something directly or describes it literally from being treated as a model. The definition also implies that a model does not interact directly with its target but exists only via the modeller's interpretation of the target and his/her purpose of model making (Valk, Berg & Eijkelhof, 2007).

Purpose of Modeling

Many authors are in agreement that as description, explanation and prediction are primary goals of science, the purposes of modeling in science are to describe, explain and predict particular aspects of the natural world (Gilbert, Pinel, Wilson, Blumberg & Wheatley, 1998; Halloun, 2004; Shen & Confrey, 2007). Here, a description refers to a statement of how things exist or behave, while an explanation means an account of why things exist or behave in one way or another (Halloun, 2007). The purposes of modeling are facilitated as the model makes it possible to simulate the phenomenon of interest mentally and externally. According to Johnson- Laird (1983), a scientific theory can exist in at least three forms of representation: propositions, mental models and images. Out of these, mental models are considered structural analogues of real-world or imagined situations. Mental simulations take place with these mental models when situations are visualized as envisioned by the mental models, a scenario of the situations runs in the mind and the results are observed with the mind's eye

(Nersessian, 1999). Simulations with models also occur externally with physical representations of natural phenomena (Morgan, 2002).

Models and Modeling

A model can be taken to be a representation of an idea, object, event, process, or system (Gilbert & Boulter, 2003). They are essential as both content products of science (Gilbert & Osborne, 1980) and in the process of coming to understand the world scientifically (Viennot, 2001). Harrison and Treagust (2000a) recommend that when analogical models (physical objects, pictures, equations, and graphs) are presented in a systematic way and capable students are given ample opportunity to explore model meaning and use, their understanding of abstract concepts can be enhanced.

Model-based Teaching and Learning

Model-based learning focuses on each individual's construction of mental models of the phenomena under study (Boulter, Buckley, & Walkington, 2001). It involves the formation, testing and subsequent reinforcement, revision, or rejection of mental models of some phenomenon (Buckley, 2000). Model formation is the construction of a model of some phenomenon by integrating pieces of information about the structure, function/behaviour, and causal mechanism of the phenomenon, mapping from analogous systems or through induction (Gobert & Buckley, 2000). An important meaning in the context of model-based learning is the idea that students must learn to be able to think with chains or networks of causal relationships that are larger than a single A Causes B relation (Clement, 2000). Model-based teaching is any implementation that brings together information resources, learning activities, and instructional strategies intended to facilitate mental model-building both in individuals and among groups of learners (Gobert & Buckley, 2000). According to Chi and Roscoe (2002), a mental model is a representation of knowledge as a set of interrelated propositions that are embedded in a structure. For the first step, they distinguish mental models for their coherence and completeness. Regarding the coherence of mental models, they describe incoherent or fragmented mental models where propositions are not interconnected in some systematic way and coherent mental models where the constituent propositions are related in an organized manner. An incoherent mental model cannot be used to give consistent and predictable explanations. On the other hand, a coherent mental model can be used to generate explanations, make predictions, and answer questions in a consistent and systematic fashion. Chi and Roscoe (2002) present a further categorization of coherent mental models as correct coherent models and flawed coherent models. A flawed coherent mental model is a model in which a coherent structure is organized around a set of beliefs or a principle that is incorrect. This model may share a number of propositions with a correct mental model, but they are interconnected according to an incorrect organizing principle. Hence, students having this model are able to answer questions adequately and consistently. Regarding the completeness of mental models, Chi and Roscoe (2002) describe complete mental models that have a majority of the key propositions and incomplete mental models that have many missing pieces. Chi and Roscoe (2002) explain that completeness is somewhat orthogonal to either coherence or correctness. Students may possess a very complete but flawed mental model, or possess a basically correct model but with sparse details. From a constructivist view on knowing and learning, models can be used as cognitive tools to promote students to think deeply, instead of the teacher supplying all the answers. In addition, students' modelling activities may offer valuable opportunities for teachers to monitor students' progress in changing their initial mental models to an understanding of particular models i.e. 'consensus models' Gilbert and Boulter (2000), which are generally accepted in Physics, chemistry, or (bio)technology (Duit & Glynn, 1996) and astronomy (Lemmer, Lemmer, & Smit, 2003).

Students' Conceptions of Basic Astronomy Concepts

High school, college and university students' notions of astronomy concepts have been investigated far less than those of elementary school students, which have been researched extensively during the last 30 years (Vosniadou & Brewer, 1992, 1994; Sharp cited in Trumper, 2006). Sadler (1987) cited in Trumper (2006) found that students in grades eight to 12 shared some of the conceptions held by elementary school children. Though more than 60% of the students held the accepted scientific concept about the day-night cycle, less than 40% knew the correct characteristics of the Moon's revolution. Furthermore, less than 30% had the right conception about the phases of the Moon, the Sun overhead and the Earth's diameter, and only 10% knew the reason for the change of seasons. Zeilik, Schau, & Mattern (1997) obtained similar results among university majors: they found that only 10% of the students held the correct view of the Moon's rotation, 23% had the right conception of the Sun overhead, and about 30% knew the accepted scientific explanation of the solar eclipse and the phases of the Moon.

According to a constructivist perspective, humans are seen as subjects who actively construct understanding from experiences using their already existing conceptual frameworks (Vosniadou, 1991; Wubbels, 1992). A constructivist way of teaching assumes the existence of learners' conceptual schemata and their active application of these when responding to and making sense of new situations. What a student learns, therefore, results from the interaction between what is brought to the learning situation and what is experienced while in it. In many cases, students' naive notions are often alternative conceptions, which may impede learning of appropriate concepts in the field despite the best efforts of instructors (Redish & Steinberg, 1999). Science educators have recommended the use of conceptual change approaches in science education (e.g., Hewson & Hewson, 1984). Conceptual change pedagogy is based on constructivist learning, recognizing that powerful theories are brought to the classroom and affect the learning of new material (Stofflet, 1994). This instructional approach holds that learners must first become dissatisfied with their existing conceptions, in addition to finding new concepts intelligible, plausible and fruitful, before conceptual restructuring occurs (Posner, Strike, Hewson & Gertzorg, 1982). The effectiveness of the conceptual change approach to science has been demonstrated in several studies (e.g., Champagne, Gunstone & Klopfer, 1985; Roth & Rosaen, 1991). This entire personal constructivist theory is grounded in Kelly's theory of Personal Constructs (Kelly, 1963) and, as noted above, many science education researchers have adopted it since his whole approach is based on the idea of the development of 'a man as a scientist'. In this constructivist spirit, several environments for learning astronomy have been developed in the last few years. Bisard and Zeilik (1998) found that allowing student groups to work on an activity for ten to 15 minutes each class period could be very productive if the activity was well-structured and not too easy. In such a way they restructured their classes into what they call 'conceptually centered astronomy [classes] with actively engaged students'; they reported significant conceptual changes in their students' thinking.

Morrow cited in Trumper (2006) proposed and performed 'kinesthetic' astronomy lessons in which, through a series of simple body movements, students young and old gained insight into the relationship between time and the astronomical motions of the Earth (rotation about its axis, and orbit around the Sun), and also about how these motions influence what we see in the sky at various times of the day and year. The only ‘equipment’ needed was a central object to represent the Sun.

Attitude towards Physics

Understanding of student attitude is very important in supporting their achievement and interest towards a particular discipline (Jebson & Hena, 2015). Attitudes are psychological constructs theorized to be composed of emotional, cognitive and behavioural components. Attitudes serve as functions including social expression, value expressive, utilitarian, and defensive functions, for the people who hold them (Newbill, 2005). To change attitudes, new attitudes must serve the same function as the old one. Instructional design can create instructional environments to affect attitude change. In the greater realm of social psychology, attitudes are typical classified with affective domain, and are part of the larger concept of motivation (Greenwald, 1989). Attitudes are connected to social cognitive learning theory as one of the personal factors that affect learning (Bandura, 1997; Newbill, 2005). Attitude was defined by Eagly and Chaiken, (1993) as “Psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour”. Attitudes toward learning chemistry is very important concept that can be described as the students’ view of knowledge, assessment, laboratory activities and the roles of instructors and students.

George (2006) cited in Olasimbo and Rotimi (2012) agreed with the assertion that attitude is comprised of two component parts which are affective in dealing with mental process. The kind of attitude builds up by students influence their learning abilities in a particular subject. Bajah (1998) explained that the position and negative attitudes of students themselves have been suggested as a contributory factor to misconceptions. George (2006) cited in Olasimbo and Rotimi (2012) further explained that inadequacies of furniture fitting and equipment in the classrooms and laboratories where teaching and learning of science subjects took place might contribute to misconceptions and alternative conceptions. Physics is considered as the most problematic area within the realm of science, and it traditionally attracts fewer students than chemistry and biology (Rivard and Straw, 2000 cited in Olasimbo and Rotimi (2012). Physics is perceived as a difficult course for student from secondary school to university and also for adults in graduate education. It is well known that both high school and college students find Physics difficult. The measurement of student's attitudes towards Physics should take into account their attitude towards learning environment (Crawley & Black, 1992). Research has shown that the attitude towards science change with exposure to science, but the direction of change may be related to the quality of that exposure, the learning environment and teaching method. (Craker, 2006 cited in Olasimbo & Rotimi, 2012)). Akinbobola (2009) suggests that the attitude of pupils is likely to play a significant part in any satisfactory explanation of variable level of performance shown by students in their school science subject. Ogunleye cited in Akinbobola (2009) in his finding reports that many students developed negative attitudes to science learning, probably due to the fact that teachers are unable to satisfy their aspiration or goals. In addition, Akinbobola (2009) showed that there is positive correlation between attitudes and performance in the science subjects. According to Johnson and Johnson (1989), cooperative learning experiences promote more positive attitudes toward the instructional experience than competitive or individualistic methodologies.

Attitude and Achievement

A study by Ali and Awan (2013) examined the relationships of attitude towards Science with the achievement in Physics, Chemistry, Biology and Mathematics. The study indicated that attitude towards Science has a positive relationship with the science achievement among secondary school students. Narmadha and Chamundeswari (2013) determined a positive relationship between attitude towards learning Science and achievement among the secondary school students.

A study by Haniza (2003) cited in Veloo et al. (2015) conducted in one of the Technical Higher Institutions, which aimed to determine attitude and motivation towards the English language, found that there is a significant relationship between attitude and academic achievement. This finding concurred with a study conducted by Thompson, Lokan, Lamb, and Ainley (2001), which showed that students who have positive attitude towards Mathematics and Science obtained better results in Mathematics and Science. They also found that it is important to inculcate in the students' positive attitude towards Mathematics and Science if they want their students to obtain good achievements. This opinion is supported by Magno (2003) cited in Veloo et al. (2015) in his study which showed that students who have positive attitude towards Physics achieved good grades in Physics. A study by Sharma, Rosemary and Wilson (2006) on 60 students found that there is difference in attitude towards Physics among students where positive attitude is higher than negative attitude. For positive attitude, students perceived Physics as important and useful whereas for negative attitude, students claimed that Physics is not important. Positive attitude towards Physics showed a positive relationship with good achievement in Physics.

Students' Attitude towards Science

Education in its general sense is a form of learning in which the knowledge, skills, and habits of a group of people are transferred from one generation to the next through teaching, training and research. Any experience that has a formative effect on the way one thinks, feels, or acts may be considered educational. Education from all perspective is viewed or aimed at preparing one for life and since it is supposed to prepare one for a better living, one must be certain on what he/she can achieve through it and from what discipline he/she can attain it. Education must draw some of its principles from psychology. This entails having good grasp of all theories that influence the teaching-learning process. Also, the quality of education that a teacher provides to students is highly dependent upon what teachers do in the classroom. Thus, preparing the students of today to become successful individuals of tomorrow, science teachers need to ensure that their teaching is effective. Understanding of student attitude is very important in supporting their achievement and interest toward a particular discipline. Students attitude toward science have been extensively studied, but research was initially focused greatly on science in general (Dawson, 2000; Osborne, Simon & Collins, 2003) and less attention was addressed to particular disciplines like Biology, Physics and Chemistry (Salta & Tzougraki, 2004). This can partly camouflage students' attitudes because science is not viewed as homogenous subjects. Students' attitudes toward science significantly alter their achievement in science. Therefore, identification and influence of attitudes came to be an essential part of educational research.

It is generally believed that students' attitude towards a subject determines their success in that subject. In other words, favourable attitude result to good achievement in a subject. A student's constant failure in a school subject can make him/her to believe that he/she can never do well on the subject thus accepting defeat. On the other hand, his/her successful experience can make him/her to develop a positive attitude towards learning the subject. This suggests that student's attitude towards science subjects could be enhanced through effective teaching strategies. It has in fact been confirmed that effective teaching strategies can create positive attitude on the students towards school subjects (Olowojaiye, 2000). Attitudes are psychological constructs theorized to be composed of emotional, cognitive and behavioural components. Attitudes serve as functions including social expression, value expressive, utilitarian, and defensive functions, for the people who hold them (Newbill, 2005).

A learner's attitude relates to all the facets of education. For example, the attitude of a learner towards science will determine the measure of the learner's attractiveness or repulsiveness to science. It follows therefore, that in order to have better students' performance in science subjects there is need to determine students' attitude to science subjects. (Sofeme & Hena, 2015).

Olatoye (2002) found that students attitude towards science has significant direct effect on students' achievement in the subject. Adesokan (2000) asserted that in spite of the recognition given to chemistry among the science subjects, it is evident that students still show negative attitude towards science subjects thereby leading to poor performance and low enrolments. Ivowi (1997) establish that in Nigeria, students poor performance in Physics have been attributed to poor teaching methods, unqualified and inexperienced Teachers, poor students attitude toward Physics, poor learning environment and gender effects.

Decline in Studying Physics

There has been a steady decline in the number of students studying science, technology or engineering over the past decade (Birrell, Edwards, Dobson & Smith, 2005). The number of students taking science in Year 11 and 12 in Australia has been falling steadily since 1976, and the proportion doing Physics has almost halved (Wood, 2004). Other research has shown that the decline in science enrolments is related to many interrelated factors such as students' academic abilities, teaching methods, the absence of motivation to study science and lack of interest in science subjects (Hassan & Treagust, 2003).

There is a growing concern that these reductions in enrolments in science and technology subjects are threatening the success of the country's innovation economy. In addition, in Australia, and also in many other countries, there is a shortage of qualified science teachers and the scientific literacy of the population is below an adequate standard (Australian Council of Deans of Science, 2003). Moreover, irrespective of the economic effects, the decline of interest in science is a serious matter for any society trying to raise the level of its scientific literacy (Osborne et al., 2003).

Hidi and Harackiewicz (2000) argued that lack of ability and lack of effort contribute to students' unsatisfactory performance and motivation. They also argue that the absence of academic motivation and lack of interest is also likely to influence students' neglect of their study. Furthermore, much of research indicates that students show most positive achievement patterns when they are focused on mastery goals. With this goal focus, researchers have investigated students' use of learning strategies which enhance conceptual understanding and recall of information to achieve goals

(Elliot & McGregor, 2001; Grant & Dweck, 2003; Meece & Miller, 2001; Wolters, 2004).

According to Osborneet al. (2003), attitudes towards science, ‘are the feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves’ (Osborne et al., 2003, p. 1053).

Declining Interest in Physics among Students from the perspective of teachers

In recent years, the number of students enrolled in Physics programs at the tertiary level has entered a spiral of decline in the developed countries. The issue is especially pronounced in more developed countries, for example, in England, Wales, and Northern Ireland (Assessment and Qualifications Alliance, 2007; Institute of Physics, 2001), Scotland (Scottish Qualifications Authority, 2007), the USA (National Science Foundation, Division of Science Resource Statistics, 2004), Australia (Dobson, 2006; Lyons, 2006), Ireland, South Korea, Mexico, Netherlands, and Spain (Organization for Economic Co-operation and Development, 2005, cited in Barmby & Defty, 2006). In the USA, the number of Physics graduates produced at the degree level over the years 1985–2004 showed a sharp decline in 1999 before recovering to the late 1980s level progressively (Hehn & Neuschatz, 2006). Ironically, students from more developed countries are high achievers in international science and mathematics tests but these students place less value on science as a passport for a better future (Martin, Mullis, Gonzalez, & Chrostowski, 2004). As basic science, such as Physics, will advance a country towards a knowledge-based economy, to be more competitive in the new global economy, it is not desirable to let Physics take a back seat. Perhaps Physics needs to be accorded more importance now than other domains in science because it is the basic language of technology and engineering. The direct consequence of falling enrolment in would be closure of Physics departments. In fact, since 1994, the number of universities in the UK offering degrees in Physics has started to decline and this has led to the emergence of ‘deserts’ in undergraduate Physics teaching (Institute of Physics, 2001). A more recent report noted that 24 university Physics departments had closed down between 1994 and 2004 in the UK (Smithers & Robinson, 2006).

Statistical data show that Physics graduates are still in great demand, especially in well-developed countries. In 2005, over a million jobs in the UK in various sectors required the exploitation of Physics-based technologies or expertise. This figure was equivalent to the total number of employees in the construction sector and to about 5% of all jobs (Centre for Economics and Business Research, 2007).In the academic arena, there is a pronounced concern on recruiting qualified Physics teachers to teach in schools. It was felt that if qualified Physics graduates could not be recruited, a decline in the number of students studying A-level Physics and a decline in interest in the subject among school leavers and university entrants can be anticipated (Engineering & Physical Sciences Research Council, 2001). It is reasonable to infer that the falling recruitment in Physics-based sectors might be due to the declining number of students taking Physics at the school and tertiary levels.

The declining enrolment in Physics at the university level and the insufficient number of Physics graduates available to work in academia, industry, and scientific communities are, in fact, a growing concern for many (Institute of Physics, 2001; Roberts, 2002). Physicists are well placed to help a country move up the economic league as their proclivity for innovation, problem-solving and promoting thinking are attributes which are highly regarded (Smith, 2008). The low enrolment in Physics at the university level will have a direct consequence on the building up of technological expertise in a country. Negative consequences could include the serious lack of industrial talent, technology-based scientists and well-qualified Physics educators. These will have direct consequences on the economy of a country.

The factors which influence students' decisions in Physics according to teachers' perspectives, as reported by Politis, Killeavy, and Mitchell (2007, p.50), are:

(1) Curriculum issues, laboratory issues, and teaching and learning resources.

(2) Students' learning experience and attitudes towards Physics (e.g., students avoid Physics because it is more difficult to achieve high grades in Physics than in other subjects; Physics is perceived to be a difficult subject by students).

(3) Issues related to the teaching of Physics (e.g., Physics requires considerable competency in mathematical sciences).

Other factors include the boring image of Physics (e.g., Reid & Skryabina, 2002, 2003, p. 520), the irrelevance of Physics (e.g., Angell, Guttersrud, Henriksen, & Isnes, 2004, p. 685), the heavy Physics curriculum (e.g., Spall, Stanisstreet, Dickson, & Boyes, 2004, p. 789), inadequate funding for resourcing the laboratory and the importance of co-curricular activities (e.g., Woolnough, 1993).

In order to study the reasons on what factors influence students to choose or not to choose to study Physics, a comprehensive scale that encompasses the various possible reasons is desirable because none of these reasons exist individually-direct and indirect effects may affect each other. Such a comprehensive scale would allow the issue to be probed at a deeper level from the responses of a large sample of Physics teachers.

Politis et al. (2007) stressed that teachers' views are important to study because 'teachers are adjudged to have a wealth of experience in relation to the factors influencing subject choice, as well as considerable insight into the mindset of the modern students' (Politis et al. 2007, p. 42). Their views are equally important as those of students as these will be another valuable source from which to obtain insights into the issue under study. They would attend to the issue in a more rational manner, thus information that fails to be drawn from students may possibly be captured from teachers and this could shed further insights on why students shy away from Physics. In a study undertaken in 2005 by the American Institute of Physics (Neuschatz, McFarling, & White, 2008), high school Physics teachers were surveyed on their teaching experience and responsibilities, their background and education, school Physics instruction and their plans for the future; only a few items, however, sought specific information about students in that survey.

The Importance of Teaching Astronomy in Schools

As Fraknoi (1996) has eloquently pointed out, astronomy education takes place in many settings outside the classroom: books and magazines, radio and TV, astronomy clubs, amateur and youth groups and camps, and on the Internet. These can be powerful influences, but they are voluntary for both students and the public. There is much to be said for including astronomy in the formal school curriculum, as long as the right material is taught, and taught well. Then we can be assured that most or all of the population will eventually be exposed to the core concepts and skills of astronomy. Through a combination of school and public education, astronomy becomes part of the national culture.

For centuries, astronomy was a core subject in a good, classical education. Why is astronomy *still* an important subject for the school curriculum?

• Astronomy has influenced our history and culture through its practical applications and its philosophical and religious implications. Our calendars have an astronomical basis. Many cultures (including ours) have written their mythology in the sky. The dual meaning of the word "heaven" demonstrates the ancient link between astronomy and religion. (Many people, of course, still believe that the "heavens" influence their daily lives, even though there is no theoretical or empirical evidence to support the pseudo-science of *astrology*.)

• Astronomy still has practical applications to timekeeping; calendars; daily, seasonal, and long-term changes in climate; and navigation. It deals with the external environmental influences on the earth: the radiation and particles from the Sun, the gravitational influences of the Sun and Moon, the impacts of asteroids and comets.

• Astronomy has advanced mathematics, science, and technology, and is a dynamic science in its own right. Many of today's most exciting science news stories concern astronomy; the 1997 exploration of Mars by *Pathfinder* is an obvious example.

• Astronomy deals with our cosmic roots, and our place in time and space. We understand the origin and evolution of our sun and our planet by studying the origin and evolution of stars and planets elsewhere. Most of the elements in our bodies were synthesized in stars. Our star is one of hundreds of billions in our galaxy, which is only one of billions of galaxies in the universe. Is our planet the only one in the universe that sustains life? As Henri Poincaré said, “Astronomy is useful...because it shows how small our bodies, how large our minds.”

• Astronomy reveals a universe which is vast, varied, and beautiful. The beauty of the night sky, the spectacle of a comet or eclipse, a color image of a nebula or galaxy—all of these have aesthetic appeal.

• Astronomy harnesses curiosity, imagination, and a sense of shared exploration and discovery. (These affective characteristics of astronomy have both positive and negative consequences: they probably explain the current fascination with alien visits and abductions!)

• In the classroom, astronomy provides a useful alternative to the experimental mode in the scientific method—namely, the observational mode. It also provides many examples of the use of simulation and modelling in science. These processes are increasingly important as part of the “scientific method.” Astronomers understand the universe by comparing its observed appearance with the predictions of theories or models; they cannot understand stellar life cycles, for instance, by breeding stars!

• Astronomy can be used to illustrate many concepts of Physics: gravitation and relativity, light and spectra, for instance. In a geography course, it provides obvious examples of comparative planetology.

• Astronomy is the ultimate interdisciplinary subject, and “integrative approach” and “cross-curricular connections” are increasingly important concepts in modern curriculum development.

• Astronomy attracts young people to science and technology. Research shows that students learn more effectively if they are interested in the material being taught. It is said that the two most popular topics for children are dinosaurs, and astronomy and space. (It would be interesting to know whether this popularity is age- or gender-dependent.)

• Astronomy can increase public awareness, understanding, and appreciation of science and technology, for all the reasons mentioned above. This is important in all countries—developing and developed.

• Unlike most sciences, astronomy can be enjoyed as a hobby. Amateur astronomers can continue to do science beyond school, and make important contributions to astronomical education and research. They also provide important grass-roots support for astronomy.

Description of the Astronomical Models

The astronomical models used in this research work include the Flashlight Model, the Earth-Moon Model, and the Model Sun-Moon. The astronomical models used in this research work have been described as follows:

The flashlight model: The flashlight model consists of a model with a flashlight or a projector. A flashlight (often called a torch) is a portable hand-held electric light. Usually, the source of light is an incandescent light bulb or light emitting diode (LED). A typical flashlight consists of a light bulb mounted in a reflector, a transparent cover (sometimes combined with a lens) to protect the source of light and reflector, a battery and a switch. These are supported and protected by a case. The flashlight model was used to explain the phases of the moon. The flashlight model was also used to visualise that students can only see one side of the moon due to the rotation of the moon and translation around the sun has the same duration.

The earth-moon model: This is a model of the earth and the moon. The earth-moon model consists of two nails (about 3 or 4 cm) inserted into a 125 cm piece of wood. The nails are separated by 120 cm. two balls whose diameters are 4 and 1 cm placed on them. The relative sizes (distances and diameters of the earth-moon-sun system) which represent a scale model of the earth-moon system maintained. The earth-moon model is used for reproduction of moon phases, reproduction of lunar eclipses and also reproducing the eclipses of the sun.

Model sun-moon: The model sun-moon is used to visualize the sun-earth-moon system with special emphasis on distances. This model takes into account the terrestrial point of view of the sun and the moon. It consists of drawing and painting a big sun of 220 cm diameter (more than 2 metres diameter) on a sheet and a cover (that is a small moon of 0.6 cm diameter (less than 1 cm diameter). In this model, the sun is fixed 235 cm away from the moon and the observer will be at 60 cm from the moon.

Identification of the Research Gap

The above review of related literature presents studies carried out in different parts of the globe, on matters pertaining to the use of astronomical models, attitudes and achievements in Physics, students' conceptions on basic astronomy concepts, declining interest in studying Physics, etc. These studies have been carried out in other countries, but not in Ghana. This study aimed to fill the missing knowledge gap on the use of astronomical models to improve students' attitudes and achievements in Physics, with the information and data obtained from Komenda College of Education in the Komenda / Edina / Eguafo / Abirem Municipal Assembly.

Summary of Literature Reviewed

The study was based on the constructivist's theory of teaching and learning. In the literature review, it was seen that constructivism theory basically concerns learning and not teaching. The emphasis is therefore laid on the learning environment and its learner centred rather than the teacher centred. The teacher's role is to ask ''what should be taught'' and ''how this can be learned'' (Proulx, 2006). Henson (2003) also cited some of the benefits of learner-centred education put forward by Dewey as including students' have increased intellectual curiosity, creativity, drive, and leadership skills. Educators who are committed to learner-centred education do challenge students within their abilities while providing reinforcement and appropriate rewards for students' success.

CHAPTER THREE

METHODOLOGY

Overview

The chapter describes the research design to be used for the study. It also describes the population, sampling and sampling procedure, instrumentation and description of validity and reliability of the instrument. The chapter ends with the description of data collection procedure/intervention used and the method of data analysis.

Research Design

Burns and Grove (2003, p. 195) define a research design as "a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings". Parahoo (1997, p. 142) describes a research design as "a plan that describes how, when and where data are to be collected and analysed". Polit, Beck and Hungler (2001, p. 167) define a research design as "the researcher's overall plan for answering the research question or testing the research hypothesis".

In this study, the quasi experimental research design was used, specifically the one-group or single group pretest-posttest design. This design seeks to find answers to the questions generated from the statement of the problem. Quasi experimental design was used because it does not include the use of random assignment or random selection. The researcher employed this design to control threats to internal validity. With this type of design the researcher attempted to find answers to questions by analyzing the variables that relate to the use of astronomical models to improve students' attitudes and achievements in Physics. Pretest, posttest and interview were used to gather data on achievement while questionnaire was used to gather data on students' attitudes for the research.

The researcher used an intact class for the test. Then introduces an intervention and tested the students to see if there were any changes after they received the instruction using the astronomical models.

Qualitative Research

Burns and Grove (2003, p.19) describe a qualitative approach as "a systematic subjective approach used to describe life experiences and situations to give them meaning". Parahoo (1997, p. 59) states that qualitative research focuses on the experiences of people as well as stressing uniqueness of the individual. Researchers use the qualitative approach to explore the behaviour, perspectives, experiences and feelings of people and emphasise the understanding of these elements.

The researcher focused on the experiences from the participants' perspective. In order to achieve the academic perspective, the researcher became involved and immersed in the study. The researcher's participation in the study added to the uniqueness of data collection and analysis (Streubert & Carpenter, 1999, p. 17). The rationale for using a qualitative approach in this research was to explore and describe the opinion of students. A qualitative approach was appropriate to capture the opinions of the students.

Profile of the Research Area / Environment

The study was conducted in Komenda College of Education in the Komenda-Edina-Eguafo-Abirem (K.E.E.A) Municipal Assembly in the Central Region of Ghana. Komenda College of Education is the only college of education in the Municipal

Assembly. The Komenda-Edina-Eguafo-Abirem Municipal Assembly is one of the Municipal Assemblies in the Central Region of Ghana created in 2008. Its capital is Elmina which is a major tourist destination town. The Municipal Assembly attains many tourist attractions such as castles, forts, beaches etc. Both the district and the constituency share common borders. The Municipal Assembly is located in the south western corner of the Central region. The Municipal Assembly shares its northern and western borders with the Western region of Ghana.

Komenda College of Education is located in Komenda / Edina / Eguafo / Abirem Municipal Assembly in the Central Region of Ghana. It is however, located about 25 kilometres away from Cape Coast in the Central Region in the southern part of the Cape Coast. It is located on a hill in a few metres away from the shore of the sea in the coastal town called Komenda. The predominant occupation of the people in this community is fishing.

Population

Parahoo (1997, p. 218) defines population as "the total number of units from which data can be collected", such as individuals, artefacts, events or organisations. Burns and Grove (2003, p. 213) describe population as all the elements that meet the criteria for inclusion in a study. Burns and Grove (2003, p.234) define eligibility criteria as "a list of characteristics that are required for the membership in the target population".

The target population for the study was all second year science students in the Colleges of Education in the Central Region of Ghana that study Physics as elective subject. The accessible population was all second year science students studying elective Physics at Komenda College of Education in the Komenda / Edina / Eguafo / Abirem (K.E.E.A) Municipal Assembly in the Central Region of Ghana. The accessible population was made up of forty-six (46) second year science students studying elective Physics.

Sampling Technique and Sample Size

Burns and Grove (2003, p. 31) refer to sampling as a process of selecting a group of people, events or behaviour with which to conduct a study. Polit et al. (2001, p. 234) confirm that in sampling a portion that represents the whole population is selected. Sampling is closely related to generalisability of the findings.

Intact class which consists of second year science 2 ‘’A’’ and science 2 ‘’B’’ science students studying elective Physics were used for the study. Forty (40) second year science students studying elective Physics were in the class which consists of science 2 “A” and science 2 ‘’B’’ and this was used for the study. Purposive sampling technique was used for the selection of this class. Thus, the science 2 “A” and science 2 ‘’B’’ class was selected on the grounds that it was the class that seems to have difficulty in understanding elective Physics; hence they have been having lower achievement in elective Physics in relation to other classes.

Research Instrument

Three main instruments were used in the study: test (pre-test and post-test), questionnaire and interview for the second year science students studying elective Physics. These instruments were described as follows:

Test: Test was one of the instruments used for the study. A test is a number of questions set to measure one’s ability and knowledge. To examine the students’ level of knowledge and ability acquired in Physics concepts and general space science / astronomy concepts, pre-test and post-test were organized for the class to assess the students. The test contained fifteen test items which demanded correct answers to be supplied by the students (Appendix II). It was based on the general space science / astronomy concepts. The test consists of two sections, A and B. Students were supposed to answer all the questions in both sections. Section A consists of questions 1 to 10, each stem is followed by four options lettered A to D. Students were supposed to read each question carefully and circle the letter of the correct option. Each question attracted one mark making a total of ten (10) marks. Section B consists of questions 11 to 15. Students were supposed to answer the questions to the best of their knowledge. Each question attracted two marks making a total of ten (10) marks. The grand total marks of both section A and B attracted 20 marks. Samples of the pre-test and post-test items are shown in Appendix II and III and samples of the scoring rubrics or the marking scheme are shown in Appendix IV and V.

To assist students in order to obtain accurate and reliable responses, the demand of the test and instructions were explained to the students. Provisions were made to ensure a sustainable examination condition with rules and regulations observed. Thirty (30) minutes was the duration of the test. Pre-test and post-test question items were similar.

Pre-test

It is a trial or examination to find the quality or value solution of a problem. A pre-test was administered to determine students' entry behaviour in terms of their ability to solve problems on general space science or astronomy concepts. The questions from the test were selected based on the Colleges of Education elective Physics syllabus / course outline for students. All the questions were on general space science / astronomy concepts.

A test was conducted with the forty (40) students to have a vivid idea on how they solve questions relating to space science / astronomy concepts. Students were arranged in such a way that they would do independent work. Thirty (30) minutes was the time duration given to the students for the test after which their question papers and scripts were collected, marked, scored and the results kept as pre-test scores. After scoring, it became clear that, the students had problems with general space science / astronomy concepts.

Intervention

Based on the pre-test results, the researcher used astronomical models to foster better understanding on general space science / astronomy concepts. Two days were selected from all the week days to be used for the intervention. These days were Mondays and Tuesdays only. The details of the intervention have been presented in this content. In all four (4) weeks were used for the intervention. The Astronomical models were used as follows:

A week before the intervention on Monday, the researcher gathered the basic materials needed for the lesson and briefed the students on what was at stake. They were told of the things they would use and the need to always be regular and punctual. Tuesday was used by the researcher to introduce the astronomical models to the students and to retune their minds for the task ahead. They were reminded of their duties as students.

Week One (1)

Flashlight model

On the first day of this week (Monday) the researcher explained the phases of the Moon by using a model with flashlight (which represented the Sun) and a minimum of five (5) students. One of the students was located at the centre representing the Earth and the others situated themselves around ‘‘the Earth’’ at equal distances to simulate different phases of the moon. To make it more attractive it was a good idea for each ‘’moon’’ to wear a white mask that mimics the colour of the moon. The students all face the ‘’Earth’’. The flashlight was placed above and behind one of the students, and begun to visualise the phases (as seen from the Earth, that is in the centre). It was very easy to discover that sometimes the mask was completely lighted, only a quarter and sometimes not at all (because the flashlight ‘’sun’’ was behind that ‘’moon’’ and its light dazzles the scene. The greater the number of students ‘’moons’’, the more phases was seen.

The flashlight model was also used to visualise that students can only see one side of the Moon due to the rotation of the moon and translation around the Sun has the same duration. The researcher begun by placing the students who played the role of Earth and only one ‘’moon’’ student: the ‘’moon’’ student was placed in front of the Earth before starting to move. So if the Moon moves 90 degrees in orbit around the Earth, it also must turn 90 degrees on itself and therefore will continue looking in front of the Earth, and so on (Figure 3.0).

Fig. 3.0: Earth-Moon model with volunteers (students) to explain the phases and the visible face of the Moon.

On the second day (Tuesday) the teacher also explained into details the key concepts of the expansion of the universe to students, feedback from the learners was analysed and conclusion drawn as well. Teacher explained the following to the students:

The origin of the universe

The theory of the origin of the universe that is most accepted today is known as the Big Bang, a huge explosion that began an expansion of space itself. There are no galaxies moving through space, but it is the space between them which expands, dragging the galaxies. For that reason, we may not speak of a centre of the universe, as nobody can speak of a country that is in the centre of the earth's surface.

The first verification of the Big Bang came with the observation of redshifts in the spectra of galaxies, and the final proof to the Big Bang theory was the detection of the cosmic microwave background.

Redshift

If at the laboratory we look with a spectroscope at the light coming from a hot gas, eg. Hydrogen, we will see some coloured lines that are typical of that gas at a determined wavelength. If we do the same with the light coming from a distant galaxy, we will see these lines slightly displaced (figure 3.1). It's called redshift, because in most galaxies the lines are moving towards that colour. The redshift of light is due to the flight of the galaxy away from us, similar to a locomotive whose whistle tone changes when it moves towards or away from us and the larger the shift, the greater the speed.

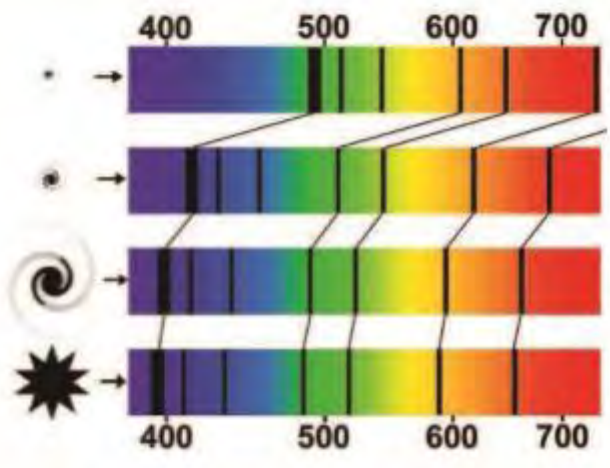

Fig. 3.1: The farther the galaxy, the more the spectrum shifts towards red, which tells us that the galaxy is moving away from us faster.

Week Two (2)

On Monday two activities were performed for the students to understand the concept of the expansion of the universe in the second week.

Activity 1: Doppler Effect

In the Doppler Effect the wavelength of a sound varies when the source is moving. We experience it in the sound of motorbikes or cars in a race: the sound is different when approaching and moving away from us. Other familiar examples are a fire truck that passes by us, the whistle of a moving train etc.

The Doppler Effect was reproduced by spinning on a horizontal plane a buzzer, for example, an alarm clock. Students placed it into a cloth bag (figure 3.2a) and tie it with a string. Students spanned it over their heads (figure 3.2b), students heard it when it approaches the viewer: when the length was shortened and the sound was higher pitched. When it goes away from the students, the length was stretched and the sound was more bass, or lower pitched. The student in the centre of rotation does not experience it.

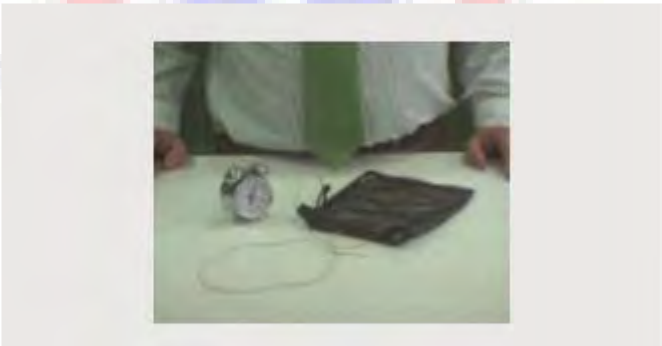

Fig. 3.2a: Alarm clock, bag and string.

Fig. 3.2b: Students revolve over their heads. Students off to one side notice the difference in the ringtone.

This is the Doppler Effect due to displacement. But it is not the one that the galaxies have with expansion. The galaxies don't move through space, it is the space between them that expands.

Activity 2: The ''stretch'' of a photon

The universe, when it expands, ''stretches'' the photons in it. The longer the duration of the photon trip, the more stretching it undergoes. Students made a model of that stretch with a semi-rigid cable, which is used in electrical installations of houses. Students were asked to cut about one meter of cable, and bend it by hand making several cycles of sinusoid, representing various waves (Figure 3.3a).

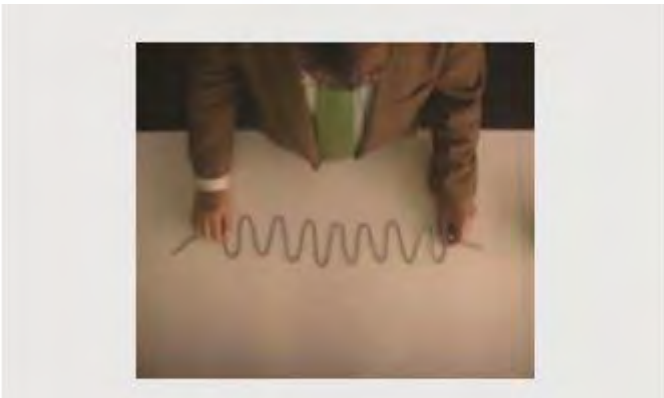

Fig. 3.3a: Making waves with rigid cable.

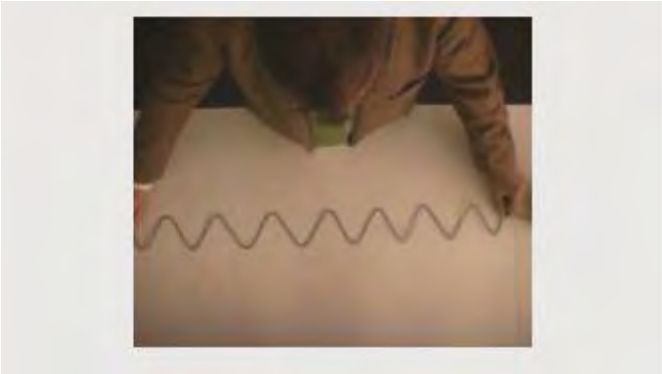

Fig. 3.3b: Same waves showing a longer wavelength.

Students were asked to take the cable with both hands and stretch (Figure 3.3b) and observe that the wavelength increases, as occurs in the radiation that comes from galaxy. The parts that move farther away from us have had more time to stretch and moved further. This indicates that the universe expands in all directions.

Earth –moon model

On Tuesday it was not easy for students to understand the geometry underlying the phases of the moon, solar and lunar eclipses. For this reason, a simple model was proposed in order to facilitate the understanding of all these processes.

Two nails (about 3 or 4 cm) were inserted into a 125 cm piece of wood. The nails were separated by 120 cm. Two balls whose diameters were 4 and 1 cm were placed on them (Figure 3.4).

Fig. 3.4: Earth and Moon model.

It is important to maintain these relative sizes as they represent a scale model of the Earth-Moon system.

Table 3.0: Distances and diameters of the Earth-Moon Sun System

Earth diameter	12,800 Km	4 cm
Moon diameter	3,500 Km	1 cm
Earth – Moon distance	384,000 Km	120 cm
Sun diameter	1,400,000 Km	440 cm = 4.4 m
Earth – Sun distance	150,000,000 Km	4,700 cm = 0.47 km

Reproduction of moon phases

On a sunny place, when the Moon was visible during the day, the Earth-Moon model was pointed towards the Moon guiding the small ball towards it (Figure 3.5). A student (observer) stayed behind the ball representing the Earth. The ball that represents the Moon was seen to be as big as the real Moon and the phase was also the same. By changing the orientation of the model the different phases of the Moon was reproduced as the illumination received from the Sun varies. The Moon-ball was moved in order to achieve all of the phases.

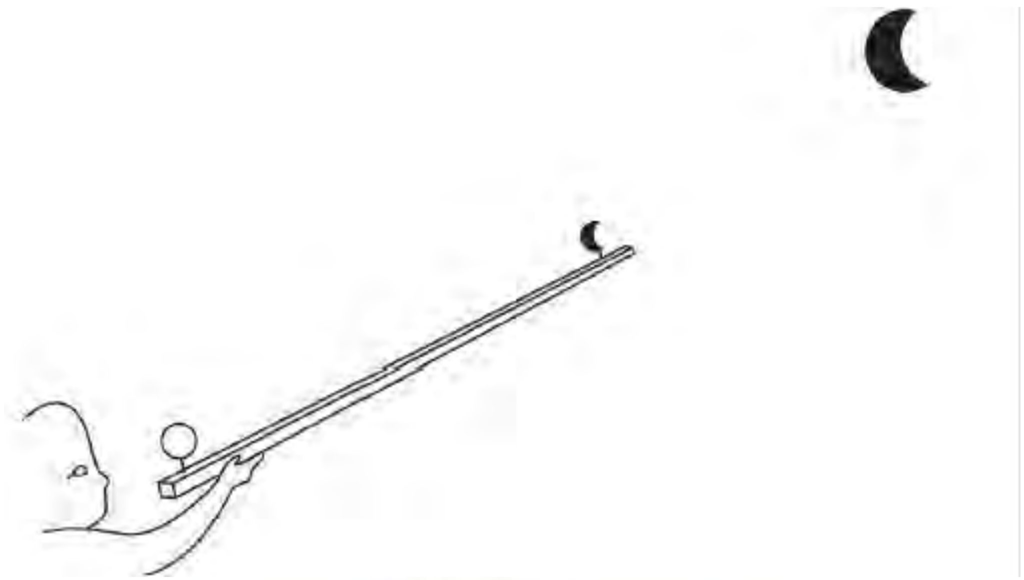

Fig. 3.5: Using the model in the patio of the college.

It was better to do this activity outdoors, but, if it's cloudy, it can also be done indoors with the aid of a projector as a light source.

Reproduction of lunar eclipses

The model was held so that the small ball of the Earth was facing the Sun (it was better to use a projector to avoid looking at the Sun) and the shadow of the Earth covers the Moon (figure 3.6a and 3.6b) as it is larger than the Moon. This was an easy way of reproducing a lunar eclipse.

Fig. 3.6a and 3.6b: Lunar eclipse simulation.

Fig. 3.7: Photographic composition of a lunar eclipse. Our satellite crosses the shadow cone produced by the Earth.

Week Three (3)

Reproducing the eclipses of the sun

The Earth-Moon model was placed so that the ball of the Moon faces the Sun (it was better to use the projector) and the shadow of the Moon was projected on the small Earth ball. By doing this, a solar eclipse was reproduced and a small spot appeared over a region of the Earth. (Figures 3.8a and 3.8b).This was done on Monday and Tuesday.

Fig. 3.8a and 3.8b: Solar eclipse simulation.

It was not easy to produce this situation because the inclination of the model has to be finely adjusted (that is the reason why there are fewer solar than lunar eclipses).

Fig. 3.9: Detail of the previous figure 3.8a.

Fig. 3.10: Photograph of the solar eclipse in 1999 over a region of the Earth's surface.

Observations

a) A lunar eclipse can only take place when it is full Moon and a solar eclipse when it is new Moon.

b) A solar eclipse can only be seen on a small region of the Earth's surface.

c) It is rare that the Earth and the Moon are aligned precisely enough to produce an eclipse, and so it does not occur every new or full Moon.

Week Four (4)

Model sun-moon

On Monday, in order to visualise the Sun-Earth-Moon system with special emphasis on distances, the researcher considered a new model taking into account the terrestrial point of view of the Sun and the Moon. In this case the researcher invited the students to draw and paint a big Sun of 220 cm diameter (more than 2 meters diameter) on a sheet and showed them that they can cover this with a small Moon of 0.6 cm diameter (less than 1 cm diameter). It was helpful to substitute the Moon ball for a hole in a wooden board in order to be sure about the position of the Moon and the observer.

In this model, the Sun was fixed 235 cm away from the Moon and the observer was at 60 cm from the Moon. The students felt very surprised that they can cover the big Sun with this small Moon. This relationship of 400 times the sizes and distances was not easy to imagine so it was good to show them with an example in order to understand the scale of distances and the real sizes in the universe. All these exercises and activities help them (and maybe us) to understand the spatial relationships between celestial bodies during a solar eclipse. This method was much better than reading a series of numbers in a book.

Fig. 3.11: Sun Model

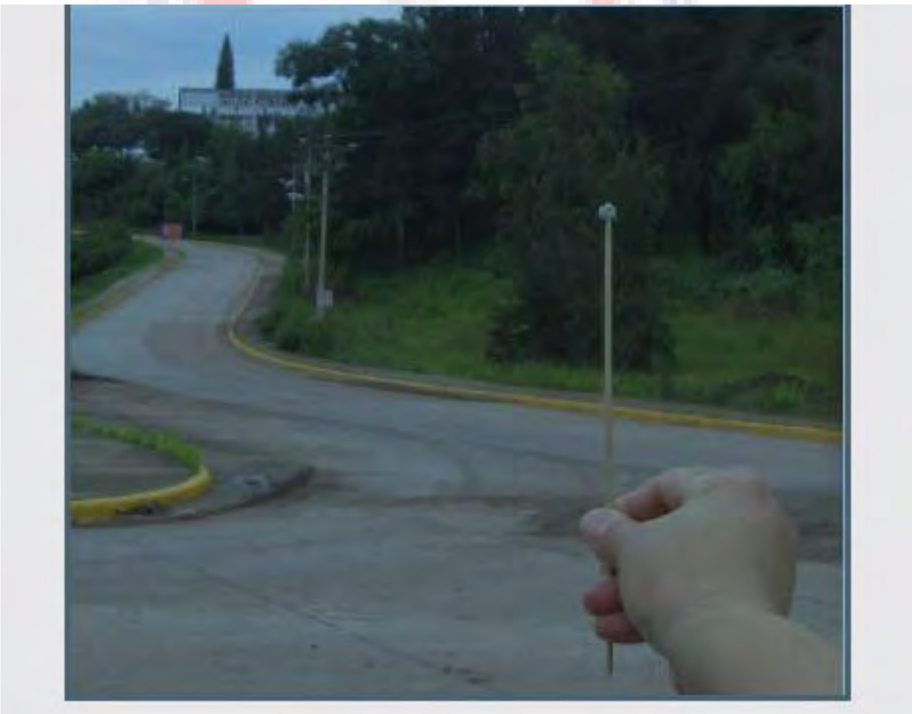

Fig. 3.12: Observing the Sun through the Moon's hole.

The second day of the week (Tuesday) involved students inquiring into the causes of lunar and solar eclipses and their relationship to the position of the Moon relative to the Earth. At the beginning of every project each student was asked to write down his or her initial beliefs about the Earth-Moon-Sun system in their learning journal (a notebook in which students keep a record of their ideas and how their ideas changed over time). Then, as a whole class, the students were asked to brainstorm and develop a list of facts and beliefs they had regarding the Earth-Moon-Sun system. At the conclusion of the class, the students were asked to compare and contrast their initial understanding about the Earth-Moon-Sun system with their post-class understanding through their learning journal and also through whole class discussions. Students worked in teams of three to four to research the orbital motions of the Earth and the Moon and how their motion influences the phases of the Moon. Students were encouraged to develop ideas and hypotheses about how the position of the Moon relative to both the Earth and the Sun can determine the Moon's phase. At the beginning of this activity, the students were provided with a few guiding questions to scaffold their exploration such as, 'Where is the Moon relative to the Earth and the Sun when it is in its new phase?' and 'Where is the Moon when a solar eclipse is occurring?' The students research these questions and try to develop questions of their own using the astronomical models with the teacher providing guidance and assistance when necessary (i.e. helping the students locate information or defining and explaining unfamiliar astronomical terms). The concluding activity of the week was a brief presentation in which the students described what they learned and how their understandings have changed during the course of using the astronomical models.

Post – Test

The posttest was conducted to find the effectiveness of the teaching and learning of the concepts taught using the astronomical models. The posttest was conducted under strict supervision which helped to obtain accurate results. The questions which were given in the pretest were similar to the posttest. This time, almost all the students were able to answer majority of the questions correctly. Samples of how most students answered the questions are provided in Appendix VII.

In conclusion, the whole exercise yielded significant impact on the students' achievement. It is presumed that the research work would serve a useful purpose to all those who will come into contact with it.

Questionnaire

Questionnaire is made up of the questions related to the subject under study. It has an advantage of being less expensive. It has a wide range coverage and greater assurance of anonymity. The researcher made printed questions and administered it to the students to answer. Both close-ended and open-ended types were used. In the close-ended questionnaire the second year science students studying Physics were required to select from list of options while in the open-ended questions, respondents were required to write their views on the questions. The questionnaire was divided into two sections. The first section that is Section A was designed to seek for background information of the respondents in respect of sex and age. The second section, Section B sought information from respondents on their attitude towards Physics scale (ATPS). The attitude towards Physics scale (ATPS) was used to measure students' attitude towards Physics. A five-point Likert scale was used. In the five-point Likert scale the respondents responded to a series of questions by indicating whether they:

1. Strongly Agree (SA-1)
2. Agree (A-2)
3. Undecided (U-3)

4. Disagree (D-4)
5. Strongly Disagree (SD-5)

The items indicated the extent to which the individuals appreciate the questions or the subject of enquiry. The five-point Likert scale type of questionnaire enables the respondents to indicate the degree of their beliefs about a given statement or object. The questionnaire for the students is of 28 items. Sample of the questionnaire for the second year science students studying Physics was provided in Appendix VIII.

Interview

Interview is a form of question notarized by the fact that it employs verbal questioning as its principal technique of data collection. It involves posing questions to respondents for answer in a face-to-face situation or by phone. It provides an opportunity to observe non-verbal behaviour of respondents. It is also likely to attract high response rate. It has the capacity for correcting misunderstanding by respondents.

Some students were interviewed in the college before the intervention and their responses were recorded by the researcher. The researcher asked the students some questions on general space science / astronomy concepts.

Semi-structured interview

Lincoln and Guba (1986) recommended triangulation as one means of increasing the credibility of researcher interpretations. Data were triangulated through multiple sources, including direct observation, interviews and the use of questionnaires. Six (6) students were interviewed once at the beginning of the course. The interview questions were semi-structured, consisting of five questions that covered a wide range of astronomy concepts with an emphasis on the concepts that relate to the Earth- Sun-Moon system. The questions were adapted or derived from the existing alternative conception literature (Barab, Barnett, Yamagata-Lynch, Squire & Keating, 2002; Barnett, Keating, Barab & Hay, 2000; Sadler 1987; Sneider & Ohadi, 1998; Treagust & Smith, 1989) and are shown in Appendix IX. The pre-interviews lasted between 20 to 30 minutes. The interviewer also asked probing questions to establish the depth of students' conceptual understanding.

Validity of the Instruments

According to Patton (2005), validity of a research instrument is how well it measures what is intended to measure. Bell (2004) also argued that validity of an instrument is important because it determines whether an item measures or describes what is intended to measure or describe. To ensure validity, the test instruments and the questionnaire were given to my supervisor and experienced Physics teachers for their comments and suggestions. The purpose of this was to assess each item's content validity, accuracy and format. After this, the test instruments and the questionnaire were pilot-tested in a mini study.

Reliability of the Instruments

Joppe (2000) defined reliability as the extent to which results are consistent over time. It implies that if the results of a study can be reproduced under a similar methodology, then the research instrument of the study can be considered as being reliable. Reliability concerns with the degree to which an experiment, test or any measuring procedure yields the same results on repeated trials (Patton, 2007). To determine the reliability of the instruments for the study, the reliability of the attitude questionnaire was determined using Cronbach alpha coefficient (α). This was done when a pilot test was conducted using second year science 2 “A” and science 2 ‘’B’’ students from Fosu College of Education. The results were run on SPSS to determine their Cronbach alpha coefficient (α). The Croncbach alpha coefficient (α) was found to be 0.852 which is very high indicating that the scale is reliable.

Administration of the Research Instrument / Data Collection Procedure

An introductory letter seeking permission for the researcher from the appropriate authorities was collected from the Head of Department, Department of Science Education of the University of Education, Winneba. The introductory letter (Appendix I) was given to the Vice Principal (Academic) of Komenda College of Education which was the study area. After a period of two weeks, the pretest and pre-questionnaire were then administered to the respondents.

A pilot study was conducted in Foso College of Education also in the Central Region of Ghana to validate the research instruments which lead to the screening, redrafting of the research instrument. An intact class of second year science 2 “A” and science 2 ‘’B’’ students studying Physics comprising 45 students were used for this exercise. As a result, statements that felt to be ambiguous or misleading were either removed or revised for clarity before the actual data collection took place. The data was edited, coded and analyzed. The main statistical tool that was used for analyzing the data was descriptive statistics. A computer software known as Statistical Package for the Social Science (SPSS) was used in the analysis. The entire questionnaire sent out to the second year science students studying elective Physics of Komenda College of Education were able to be retrieved. Thus, a 100% retrieval rate.

Data Collection Procedure

The investigation took place when the college was in session for six (6) weeks, so that all subjects have sufficient time to function smoothly. Also to ensure a high rate of return of the questionnaire, it was directly administered to the second year science students studying Physics in the classroom. Directions were given to facilitate an honest and serious set of answers and to ensure anonymity and confidentiality of the respondent. The respondents were given one week to respond to all items on the questionnaire adequately.

Raw data was collected using questionnaire distributed to respondents. The data to be used in the study was made up of both the primary and secondary data. Secondary data employed in the study consists of a literature review of existing reports, and works. Thus, previous studies relating to the subject matter as well as from journals, magazines, newspapers, textbooks and relevant websites on the subject matter.

The primary data was obtained from the field through questionnaire which was administered to the respondents, through interview and test of students by the researcher. The primary source was considered because such a source of material is always in its original form and relatively free from editing, alteration or modification. As such it tends to be free from external influence, judgement and bias of others, which might lead to unsound interpretation by the researcher.

Scoring the Items on the Instrument

The responses to the items of the questionnaire were scored using five-point Likert scale depending upon whether the items that were worded positively or negatively.

Positive stated items such as the; the usefulness of Physics and the like of doing Physics were coded or scored as follows:

- Strongly Agree (SA) = 1
- Agree (A) = 2
- Undecided (U) = 3
- Disagree (DA) = 4
- Strongly Disagree (SD) = 5

This procedure was reversed for negative statements such as; Physics is a male domain, Physics anxiety, was coded or scored as follows:

- Strongly Agree (SA) = 5
- Agree (A) = 4
- Undecided (U) = 3
- Disagree (DA) = 2
- Strongly Disagree (SD) = 1

The scores of each respondent that is the students were summed up to obtain a raw attitude scores. The total scores were a measure of their attitudes.

Data Analysis

There are 28 items in the questionnaire and these were grouped into four (4) interest variables each with seven items. The interest variables were as follows:

a. Physics as a male domain

b. Like doing Physics (interest)

c. Physics anxiety

d. Usefulness of Physics

The table below shows the items in the questionnaire that contributed to the various interest variables.

Table 3.1: Attitudinal variables and items

Attitudinal Variables	Items on Questionnaire
Physics Is a Male Domain	5,8,13,17,20,21,27
Liking for Physics	2,4,10,14,15,19,25
Physics Anxiety	3,9,12,16,22,23,26
Usefulness of Physics	1,6,7,11,18,24,28

The data collected was analyzed using percentages and descriptive procedures. These methods were considered appropriate because they make the analysis and comparisons of the responses easier. The score of each item was found as a percentage of the total score. Conclusions were then made by comparing the percentages of responses.

Quantitative methods were used in the analysis of data. The data collected were edited, encoded and analyzed through the help of Statistical Package for Social Sciences (SPSS) and Excel.

CHAPTER FOUR

RESULTS / FINDINGS AND DISCUSSIONS

Overview

This chapter presents the data analysis and interpretation of the findings. The chapter presents the questionnaire return rate, demographic data and the analysis according to the research objectives. This chapter also presents the results of the study. The results are presented using tables, figure and pie chart.

Questionnaire Return Rate

Questionnaire return rate is the proportion of the questionnaires returned after they have been issued to the respondents. Out of forty (40) students sampled by the study, all the students filled and returned the questionnaires. These return rates were above 95% and hence deemed adequate for data analysis as recommended by Mugenda and Mugenda (2003).

Demographic Characteristics of Respondents

The demographic information of the students was based on sex and age. Data is presented in the following section:

Table 4.1: Sex of respondents

	Frequency	Percent	Percent	Cumulative Percent
Male	26	65.0	65.0	65.0
Female	14	35.0	35.0	100.0
Total	40	100.0	100.0	

Table 4.1 and Figure 4.1 show that out of the 40 students who took part in the study, 65% are males' whiles 35% are females.

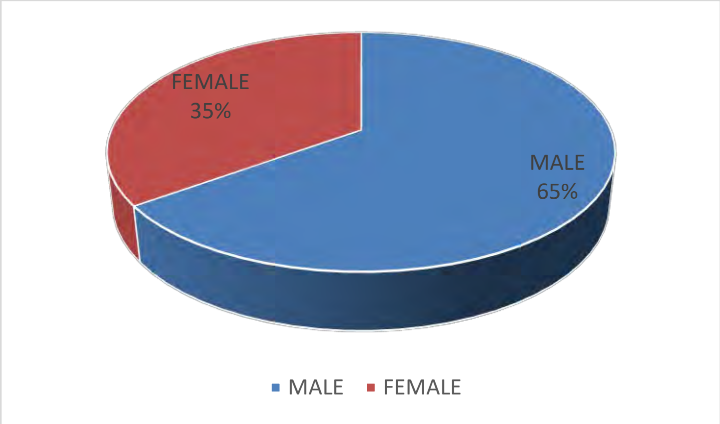

Figure 4.1: Sex of respondents

Table 4.2: Age of students

	N	Minimum	Maximum	Mean	St. Deviation
Age of students	40	20	27	22.6	1.53
Valid N (listwise)	40				

Table 4.2 gives the range of age of respondents

From Table 4.2, it is shows that the age of respondents range from 20 to 27 (M=22.6, SD= 1.53). The mean age of the students was 22.6 and the standard deviation of the ages of the students was 1.53.

Pre-test and post-test scores

It was necessary to find out the pre-test and post-test scores of the students whether there is significant difference between their scores. Hence, the Pre-test and post-test scores are presented in Table 4.3 which describes the students' scores.

Table 4.3: Descriptive statistics of pre and post-test scores

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test score	40	2	11	5.6	2.12
Post-test Score	40	10	18.0	12.2	5.49
Valid N (listwise)	40				

The results in Table 4.3 show that the pre-test scores range from 2 to 11 (M=5.6, SD=2.12). The students had a pre-test mean score of 5.6 and a standard deviation of 2.12. Also the post-test scores range from 10 to 18 (M=12.2, SD= 5.49). The post-test mean score was 12.2 and a standard deviation of 5.49. This shows that there was significant difference between the pre-test and post-test scores, it was convincing that the use of the astronomical models has improve students attitudes and achievements in Physics.

It was necessary to find out the independent sample t-test between the pre-test and post-test to show whether there was significant difference between the pre-test and the post-test scores of the students. This is shown in Table 4.4.

Table 4.4: Independent sample t-test

Test	N	M	SD	t	P
Pre-Test	40	5.63	2.12	-7.11	.000
Post-Test	40	12.25	5.49		

Table 4.4shows independent sample t-test between the pre-test and post-test of second year science students on the use of astronomical models in improving students' attitudes and achievements in Physics. It also shows that there was significant difference between the pre-test scores (M=5.63, SD=2.12) and the post-test scores (M=12.25, SD=5.49), t=-7.11, p= .000). This suggests that the use of astronomical models has helped in improving students' attitudes and achievements in Physics.

Percentage correct responses were computed for the ten items in the pre-test and post-test and presented in Table 4.5.

Table 4.5: Percentage correct responses and summary of independent sample t-test

(Pre-test and Post-test)

		One or single Group		
		Pre-Test	**Post-Test**	
Item	**N**	**%**	**%**	***P***
1	40	15	55	.211
2	40	17.5	52.5	.040
3	40	72.5	82.5	.315
4	40	32.5	75	.410
5	40	35	67.5	.004
6	40	47.5	65	.161
7	40	50	72.5	.829
8	40	85	85	.025
9	40	12.5	47.5	.222
10	40	25	67.5	.001

An examination of the items in Table 4.5 revealed that students had higher correct responses in the post-test than in the pre-test. This suggests that students performed better in the post-test after the intervention than in the pre-test before the intervention. There was significant difference in the responses between the pretest and posttest for items 2, 5, 8, and 10. There was no significant difference for items 1, 3, 4, 6, 7, and 9.

Attitude Analysis

Students' attitude analysis has been presented in Tables 4.6, 4.7, 4.8 and 4.9.

Table 4.6: Attitude descriptive statistics

	N	Min	Max	Mean	SD
ATTITUDE	40	48.00	122.00	89.4875	15.63
Valid N (listwise)	40				

The results in Table 4.6 show that the attitude scores of students ranges from 48 to 122.00 (M=89.48, SD=15.63). From table 4.6 it indicates that on the average, majority of the students have positive attitudes in Physics.

The results of independent sample t-test between the responses from students pre-questionnaire and post-questionnaire are presented in table 4.7.

Table 4.7: Attitude independent sample t-test between pre-test and post-test

Test	N	M	SD	T	P
Pre-Test	40	86.85	15.82	-1.521	.132
Post-Test	40	92.12	15.18		

From Table 4.7, the results of the independent samples t-test revealed that there was significant difference in attitude in the pretest (M=86.85, SD=15.82) and posttest (M=92.12, SD=15.18), P=.132. This indicates that the intervention help in improving student's attitude in Physics. Responses in the post-test were therefore significant.

Table 4.8 shows the descriptive statistics of pre-questionnaire attitude scores.

Table 4.8: Pre-questionnaire attitude descriptive statistics

	N	Min	Max	Mean	Std. Deviation
Question 1	40	3.00	5.00	4.3500	.66216
Question 2	40	1.00	5.00	2.6750	1.09515
Question 3	40	1.00	5.00	2.6500	1.45972
Question 4	40	1.00	5.00	2.4750	1.32021
Question 5	40	1.00	5.00	2.7500	1.19293
Question 6	40	1.00	5.00	2.3750	1.29471
Question 7	40	1.00	5.00	2.9750	1.25038
Question 8	40	1.00	5.00	3.5000	1.17670
Question 9	40	1.00	5.00	1.8750	1.01748
Question 10	40	1.00	5.00	3.3000	1.36250
Question 11	40	1.00	5.00	2.8500	1.23101
Question 12	40	1.00	5.00	3.9250	1.14102
Question 13	40	1.00	5.00	3.1000	1.41058
Question 14	40	1.00	5.00	3.8000	1.18105
Question 15	40	1.00	5.00	2.8750	1.30458
Question 16	40	1.00	5.00	3.0250	1.44093
Question 17	40	1.00	5.00	3.2750	1.46738
Question 18	40	1.00	5.00	2.5250	1.21924
Question 19	40	1.00	5.00	3.6250	1.23387
Question 20	40	1.00	5.00	3.0000	1.32045
Question 21	40	1.00	5.00	2.5000	1.21950
Question 22	40	1.00	5.00	2.9250	1.36603
Question 23	40	1.00	5.00	3.9250	1.16327
Question 24	40	1.00	5.00	3.9750	1.16548
Question 25	40	1.00	5.00	3.5500	1.23931
Question 26	40	1.00	5.00	2.5750	1.17424
Question 27	40	1.00	5.00	3.3000	1.32433
Question 28	40	1.00	5.00	3.1750	1.25856
Valid N (listwise)	40				

The results in table 4.8 show many students have mean interest scores above 3 and few have mean interest scores below 2. This suggests that students have positive attitudes in Physics before the treatment.

Table 4.9 also shows the descriptive statistics of pre-questionnaire attitude scores.

Table 4.9: Post-test attitude descriptive statistics

	N	Min	Max	Mean	Std. Deviation
Question 1	40	3.00	5.00	4.6000	.54538
Question 2	40	1.00	5.00	3.2250	1.22971
Question 3	40	1.00	5.00	2.7500	1.46322
Question 4	40	1.00	5.00	2.7750	1.20868
Question 5	40	1.00	5.00	2.8000	1.36250
Question 6	40	1.00	5.00	2.2500	1.19293
Question 7	40	1.00	5.00	3.5750	1.27877
Question 8	40	1.00	5.00	4.0250	1.02501
Question 9	40	1.00	4.00	1.8250	.84391
Question 10	40	1.00	5.00	3.2250	1.62493
Question 11	40	1.00	5.00	3.5250	1.28078
Question 12	40	1.00	5.00	4.1250	1.11373
Question 13	40	1.00	5.00	3.2500	1.39137
Question 14	40	1.00	5.00	4.0750	1.04728
Question 15	40	1.00	5.00	3.0500	1.25983
Question 16	40	1.00	5.00	3.4250	1.35661
Question 17	40	1.00	5.00	3.3000	1.53923
Question 18	40	1.00	5.00	2.3250	1.22762
Question 19	40	1.00	5.00	4.2250	1.02501
Question 20	40	1.00	5.00	3.5000	1.39596
Question 21	40	1.00	5.00	1.8750	.93883
Question 22	40	1.00	5.00	2.4500	1.37654
Question 23	40	1.00	5.00	4.3000	1.04268
Question 24	40	1.00	5.00	4.3750	.92508
Question 25	40	1.00	5.00	3.7000	1.36250
Question 26	40	1.00	5.00	2.3000	1.13680
Question 27	40	1.00	5.00	3.3750	1.27475
Question 28	40	1.00	5.00	3.9000	1.33589
Valid N (listwise)	40				

From Table 4.9, it is observed that many students have mean attitude scores above 3 and few have mean attitude scores below 2. This suggests that students have positive attitudes in Physics after the treatment. This portrays almost the same results in the students' pre-questionnaire attitude.

Attitude of students (male and female) towards Physics

In order to find the attitude of male and female students towards Physics, independent sample t-test was used. The results are shown in Table 4.10.

Table 4.10: Attitude independent sample t-test by sex

Test	N	M	SD	t	P
Male	26	92.34	14.18	2.28	.025
Female	14	84.17	17.05		

The results in Table 4.10 show that there is significant difference in attitude of male and female students towards Physics. Independent sample t-test revealed that males have positive attitudes towards Physics (M=92.34, SD=14.18) than females (M=84.17, SD=17.05), p= .025.

Analysis of Interview Data

Results from the interview revealed some misconceptions students have about some concepts in astronomy. Only six students were interviewed that was four men and two women. The names used in this research work for the interview are pseudo-names. Five of the six students interviewed (83.3%) believed that the shape of the earth is spherical. Only one (16.7%) student said the earth is oval. This is seen in the following extracts:

1. Researcher: What is the shape of the Earth and the Moon? Why does the Earth have day and night?
2. **Jonas**: The shape of the Earth and the Moon is spherical. The Earth has day and night because of the rotation of the earth around the sun.
3. **Foster**: The shape of the Earth and the Moon is spherical. The Earth has day and night because of the rotation of the earth around the sun.
4. **Jocelyn:** The shape of the Earth and the Moon is spherical. The Earth has day and night because of the rotation of the earth around the sun.
5. **Rita:** The shape of the Earth and the Moon is spherical. The Earth has day and night because of the revolution of the earth around the sun. When it is rotating, it faces the sun, the side that faces the sun experiences day and the other side experiences night.
6. **Charles:** The shape of the Earth and the Moon is oval in shape. The Earth has day and night because of the rotation of the earth around the sun.
7. **Robert:** The shape of the Earth and the Moon is spherical in shape. The Earth has day and night as a result of the rotation of the earth around the sun.

Many of the students (3) stated that the earth takes between 365-366 days to go around the sun (50%). Also, two students said it takes 365 and a quarter day (33.3%). Only one student said it takes the earth 24 hours to go round the sun (16.7%). This is what the students had to say:

8. Researcher: How long does the Earth take to go around the Sun?
9. **Charles**: 365 -366 days.
10. **Jocelyn**: 365 ¼ days.
11. **Foster**: 24 hours.

12. **Robert**: 365-366 days.

13. **Jonas**: 365 ¼ days.

14. **Rita**: 365 days.

The results show that students had various views of what cause the phases of the moon. Two students said it is caused by the earth reflecting the sun (33.3%). Three students said it caused by the rotation of the moon (50%). One student said it is caused by day and night (16.7%). This is seen in the following extract:

15. Researcher: Can you tell me what causes the phases of the Moon?
16. **Rita**:The phases of the moon is caused by the moon as a reflection of the sun so if the sun is very hot we have full moon total reflection occurs that is while at times we have full moon and half-moon.
17. **Robert**: The phases of the moon is caused by the moon cannot produce light as a result of how the reflects light therefore the moon taps its source of light from the sun that is while we have phases of the moon.
18. **Jocelyn**: The phases of the moon are caused by day and night.
19. **Jonas**: The phases of the moon are caused by when we have the moon rotating (as a result of the rotation) sometimes full and sometimes partial (half) moon.
20. **Charles**: The phases of the moon are caused by the rotation and revolution of the earth.
21. **Foster**: The phases of the moon are caused as a result of the movement of the earth.

The views of students on the position of the sun, moon and earth for a lunar eclipse to occur is shown in the following extract:

Many of the students (3) stated that for lunar eclipse the earth is positioned between the sun and the moon (50%). Also, three students said that the sun is positioned between the earth and the moon (50%). This is what the students had to say:

22. Researcher: Can you show me the position of the Sun, Earth and Moon for a lunar eclipse to occur?
23. **Jonas:** For lunar eclipse the sun is at the left, the earth is in the middle and the moon is at the right.
24. **Foster:** For lunar eclipse the earth is in between the sun and the moon obstructing the sun's rays.
25. **Rita:** For lunar eclipse the sun is in between the earth and the moon obstructing the sun's rays…… that is the earth and the moon are at other sides of the sun.
26. **Jocelyn:** For lunar eclipse the earth is in between the sun and the moon obstructing the sun's rays that is the earth and the moon are at other sides of the sun.
27. **Robert:** For lunar eclipse the earth is in between the sun and the moon obstructing the sun's rays…… The shadow of the earth is cast unto the moon.
28. **Charles:** For lunar eclipse the sun is in between the earth and the moon obstructing the sun's rays……. The shadow of the earth is cast unto the moon.

The views of students on the position of the sun, moon and earth for a solar eclipse to occur is shown in the following extract:

All the students (6) were not able to state the position of the sun, moon and earth for solar eclipse to occur (100%). This is what the students had to say:

29. Researcher: Can you show me the position of the Sun, Earth and Moon for a solar eclipse to occur?

30. **Robert:** For solar eclipse the moon is in between the sun and the earth that is the moon is in the middle, the sun is at the left and the earth is at the right.
31. **Rita:** For solar eclipse the moon is in between the sun and the earth that is the moon is in the middle, the sun is at the left and the earth is at the right.
32. **Jocelyn:** For solar eclipse the moon is in between the sun and the earth that is the moon is in the middle, the sun is at the left and the earth is at the right.
33. **Foster:** For solar eclipse the moon is in between the sun and the earth that is the moon is in the middle, the sun is at the left and the earth is at the right.
34. **Jonas:** For solar eclipse the moon is in between the sun and the earth that is the moon is in the middle, the sun is at the left and the earth is at the right.
35. **Charles:** For solar eclipse the moon is in between the earth and the sun.

The difference between lunar eclipse and a new moon is seen in the following passages:

All the students (6) were not able to state the difference between lunar eclipse and a new moon(100%). This is what the students had to say:

36. Researcher: What is the difference between a lunar eclipse and a new moon?
37. **Jocelyn:** Lunar eclipse occurs when the earth comes in between the sun and the moon but new moon is when the sun's rays are totally reflected directly unto the moon.
38. **Foster:** Lunar eclipse occurs when the earth comes in between the sun and the moon but new moon is when the sun rays are being obstructed on reaching the earth but new moon is the phase of the moon that appears first that is the first phase of the after conjunction with the sun.
39. **Jonas:** No idea.

40. **Robert**: Lunar eclipse occurs when the earth comes in between the sun and the moon but new moon is the rotation of the moon at the beginning or ending that is after 28 days.
41. **Charles**: Lunar eclipse occurs because of the position of the earth and the moon during rotation and revolution but a new moon depends on the position of the earth and the appearance of the moon on the earth.
42. **Rita:** Lunar eclipse occurs when the sun comes in between the earth and the moon whereby the earth casts its shadow on the earth but a new moon is as a result of the movement of the earth.

The difference between solar eclipse and a full moon is seen in the following passages:

All the students (6) were not able to state the difference between solar eclipse and a full moon (100%). This is what the students had to say:

43. Researcher: What is the difference between a solar eclipse and a full Moon?
44. **Jonas**: Solar eclipse occurs when the earth comes in between the sun and the moon but full moon occurs when there is total darkness on the earth's surface that is during solar eclipse.
45. **Foster**: Solar eclipse occurs when the moon comes in between the sun and the earth obstructing rays from reaching the earth but full moon is the illuminated phase of the moon that appears after it has an encounter with the sun.
46. **Robert**: Solar eclipse occurs when the sun comes in between the moon and the earth obstructing rays from reaching the earth but full moon appears in the morning and half-moon in the evening.

47. **Rita**: Solar eclipse occurs when the sun comes in between the moon and the earth obstructing rays from reaching the earth and we get partial darkness of the sun but full moon on its usual rotation of the moon that is at the beginning of the moon or at the ending of the month usually after 28 days.
48. **Charles**: Solar eclipse occurs when the moon comes in between the sun and the earth obstructing rays from reaching the earth but full moon is when the moon is in its fullest view depending on the position of the earth.
49. **Jocelyn**: Solar eclipse occurs when the earth comes in between the sun and the earth but full moon occurs when the earth is far away from the moon.

Discussion

Understanding the solar system involves a number of related conceptual areas that are clearly of importance in relation to students' existing conceptions and are difficult to explain since they do not match their daily observations. They include a perception of spatial aspects of the Earth, a conception of day and night, of seasonal change, etc., which include compound movements of the Moon, the Sun and the stars. Students in the class conducted both individual activities in the classroom; the paired and group activities were also conducted in the classroom. They also participated in guided discussions, arguing about their different notions and continuously assessing their significance, and checking their validity. The students were active constructors of their own knowledge, while the process of knowledge acquisition was greatly assisted by interactions with peers and in particular, with the teacher.

The study sought to find out the effect of astronomical models on students' achievements and attitudes in Physics. The findings of this study show that students improved their basic astronomy concepts in a statistically significant way. The results show that the use of astronomical models is effective in eliminating misconceptions and thus led to high achievement scores in Physics. This is consistent with the findings of other researchers. For example, Stahly et al. (1999) examined third graders' ideas about lunar phases prior to and following instruction designed to promote conceptual change. Their research used the responses of only four students but also provided rich details of the students' responses to semi structured interview questions. The interviews included two-dimensional and three-dimensional representations (drawing and models) to explore students' understandings. Post-test results revealed that the instruction was partially effective at addressing students' misconceptions about the phases of the Moon. All the students in the study revealed some scientific conceptions and some alternative conceptions, including inaccurate notions that were resistant to change. So, misconceptions about the phases of the Moon remained, but instruction did result in improvement. Diakidoy and Kendeou (2001) cited in Trumper (2006) reported a study they carried out with fifth-grade students learning astronomy concepts such as the Earth's shape and rotational movement, and the day-night cycle. Their findings showed that students who received experimental constructivist instruction in the targeted astronomy concepts demonstrated significant improvement in their understanding and learning of these concepts, in contrast to students who received standard, textbook-based instruction. Bakas and Mikropoulos (2003) cited in Trumper (2006) developed an educational tool based on the technologies of Virtual Reality. The objective was to create an interactive three-dimensional artificial learning environment within which students were able to come into immediate contact with the movements of the planets and the Sun and the phenomena occurring in our solar system, in particular the Earth-Sun system. The purpose was also to provide students with environments that gave them the opportunity to experience cognitive conflict and to reject possible misunderstandings engendered by them. Findings showed that after the interaction with the virtual environment, students aged 12–13 created fewer, more concrete and scientifically accepted mental models. Taylor, Baker and Jones (2003) cited in Trumper (2006) reported significant positive outcomes from a teaching package in astronomy education based on what they called Mental Model-building Strategy. In the social constructivist perspective, referred to in Vygotsky (1978)'s work, thinking processes and knowledge development are seen as the consequence of personal interactions in social contexts and of appropriation of socially constructed knowledge. In any case, knowledge acquisition and conceptual change take place through a process of formulation, reformulation and reinterpretation of knowledge, in which the learner is continuously evaluating his or her significance, comparing different points of view and testing their validity. The learner is an active constructor of his/her own knowledge, and the process of knowledge acquisition is greatly assisted by interactions with peers and in particular with a teacher acting at the zone of proximal development (Vygotsky, 1978). In this constructivist spirit, several environments for learning astronomy have been developed in the last few years. Bisard and Zeilik (1998) found that allowing student groups to work on an activity for ten to 15 minutes each class period could be very productive if the activity was well-structured and not too easy. In such a way they restructured their classes into what they call 'conceptually centered astronomy [classes] with actively engaged students'; they reported significant conceptual changes in their students' thinking. Morrow (2000) proposed and performed 'kinesthetic' astronomy lessons in which, through a series of simple body movements, students young and old gained insight into the relationship between time and the astronomical motions of the Earth (rotation about its axis, and orbit around the Sun), and also about how these motions influence what we see in the sky at various times of the day and year. The only ‘equipment’ needed was a central object to represent the Sun.

The study revealed that Astronomical models have not improved students’ attitudes in Physics. This suggests that the astronomical models did not significantly change the attitude of the students. This could be due to the fact that attitudes are difficult to change and also the number of weeks for the intervention was not enough for the attitudes of students to change very fast. Bajah (1998) explained that the position and negative attitudes of students themselves have been suggested as a contributory factor to misconceptions. George (2000) cited in Olasimbo and Rotimi (2012) further explained that inadequacies of furniture fitting and equipment in the classrooms and laboratories where teaching and learning of science subjects took place might contribute to misconceptions and alternative conceptions. Physics is considered as the most problematic area within the realm of science, and it traditionally attracts fewer students than chemistry and biology (Rivard and Straw, 2000 cited in Olasimbo and Rotimi, 2012).

The study also revealed that students have misconceptions about the solar eclipse, lunar eclipse and phases of the moon. Lightman and Sadler (1987) cited in Trumper (2006) found that students in grades eight to 12 shared some of the conceptions held by elementary school children. Though more than 60% of the students held the accepted scientific concept about the day-night cycle, less than 40% knew the correct characteristics of the Moon’s revolution. Furthermore, less than 30% had the right conception about the phases of the Moon, the Sun overhead and the Earth’s diameter, and only 10% knew the reason for the change of seasons. Zeilik, Schau and Mattern

(1998) obtained similar results among university majors: they found that only 10% of the students held the correct view of the Moon's rotation, 23% had the right conception of the Sun overhead, and about 30% knew the accepted scientific explanation of the solar eclipse and the phases of the Moon.

A considerable amount of research has been conducted to determine both children's and adults' conceptions of Moon phases only (Stahly, Krockover, & Shepardson, 1999; Trundle, Atwood & Christopher, 2002 cited in Feral, 2007). "There is evidence that people with varied levels of schooling and training from elementary school through in-service teachers do not understand the cause of moon phases" (Trundle et al., 2002, p. 634) and "some of them still hold misconceptions even after they were provided a scientifically correct explanation". Callison and Wright (1993), cited in Feral (2007) for example, determined pre-service elementary teachers' scientifically inaccurate views about Moon phases before the instruction and concluded that some of them kept inaccurate views after the instruction. Analysis of the research indicates that the most common misconception of the cause of Moon phases held by students is "Earth's shadow falling on the Moon". Trumper (2003) cited in Feral (2007) acknowledges that students frequently come to their lessons having constructed their own explanations for many of the easily observed astronomical events, and that these children's notions are at variance with the accepted view. This naïve or intuitive knowledge in science was previously described in some research (Driver, Guesne, & Tiberghien, 1985). Although naïve views decrease as the age increases, misconceptions frequently pass on into adulthood (Bisard et al. 1994; Trumper, 2001). Bisard et al. (1994) surveyed 708 students including middle school students, science majors in teaching-methods classes, and general education majors taking an elementary science methods class.

Stahly et al. (1999) looked into third graders' ideas about the Moon's phases both before and after instruction. Their methods used interviews from four students from a third grade class of 21. These students varied in abilities and were chosen based on criteria that included their communication skills. The instruction the students received consisted of 6 lessons over a period of 3 weeks, which included the presentation of a 3Dimensional model of the Sun/Earth/Moon system. With the researcher acting as a teacher, the material was presented to the students to facilitate their learning while their concepts and conceptual changes were monitored and recorded. Results were obtained from interviews and drawings made by the students. Stahly et al. (1999) found some scientific ideas present after instruction among the four "key informants" they interviewed and observed, but they also found that "The third grade students also seemed to maintain some aspects of their original conceptions representing the resilience of their ideas."

Trumper (2000) surveyed students entering an introductory astronomy course with an instrument of 19 questions covering several topics in basic astronomy. Question 2 on his survey inventoried conceptions about the phases of the Moon. His results showed 31.6 % of students believed that the phases of the Moon are caused by Earth's shadow. Correct answers were given by 51.3 % of the students (Trumper, 2000, p. 10).

Barnett and Morran (2002) investigated student conceptions about the Moon and utilized a curriculum to help students develop an understanding of the Sun/Earth/Moon system. The approach used an "eclectic" mix of instructional materials including a 3Dimension computer model.

Results from the study which included analysis of interviews with the students were mixed. Barnett and Moran (2002) sum it up as follows. The findings in this study suggest that students at Grade 5 level can develop a sophisticated understanding of the phases of the Moon and eclipses and that instruction does not necessarily need to directly address students' alternative frameworks to promote conceptual change.

Fanetti (2001) examined “The relationships of scale concepts on college age students’ misconceptions about the cause of the lunar phases.” Her hypothesis was that students who had skewed views of the scale of the Earth/Moon system were more apt to assume the Moon’s phases were caused by Earth’s shadow (Fanetti, 2001, p. 65). The results of the research did not show a statistically significant connection between conceptions of the Moon’s phases and scale size of the Earth/Moon system.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Overview

The main focus of this study was using astronomical models to improve student's attitudes and achievement in Physics at Komenda College of Education. This chapter attempts to summarize the major findings, draw conclusions and put forth recommendations for implementation and for the furtherance of study. This chapter also presents a summary of the study. It also draws conclusion from the findings and finally made recommendations for practice and for future research.

Summary of findings

The study was carried out to use astronomical models to improve students' attitudes and achievements in Physics at Komenda College of Education. Four attitudinal variables, namely: like doing Physics (interest), usefulness of Physics, Physics as a male domain and Physics anxiety were used. The study was done at Komenda College of Education. The results of the data analysis have provided a number of findings with respect to the attitudes that students have towards Physics.

First and foremost, the study revealed that the students believe that, the subject Physics because of its conceptual nature, should be preserve for boys, in the sense that, even most of the great and greatest scientist that had ever lived, happen to be all men like Isaac Newton, Michael Faraday, Albert Einstein, etc.

Again, the second year science students of Komenda College of Education who were involved in the study did not support the idea that the subject Physics has some, if not many usefulness. This notion can be as a result of a precondition mind of the students either by their peers, siblings or parents as to what they want them to be in future. As a result, students tend to undermine and overlook the possible benefits or prospects that come with studying the subject Physics.

Furthermore, the study revealed that majority of the students had little or no interest at all in the subject Physics. The students pointed out that, looking at the subject Physics, there are simply few role models to motivate or to serve as a driving force for them to pursue the subject at higher educational levels.

In this same view the study revealed that, students lacked interest in the subject Physics, due to the way it is been handled by the Physics teachers. Most of the students complained of having no teaching and learning materials around during lesson periods, few or no practical sessions and above all, the methodology of most teachers are not motivational enough to make them like the Physics. .

The main aim of the study was to identify the effect of astronomical models on student's attitudes and achievements in Physics. The study sought to find out the effect of astronomical models on students' attitudes and achievements in Physics.

The findings of this study show that students improved their basic astronomy concepts in a statistically significant way. The results show that the use of astronomical models is effective in eliminating misconceptions and thus led to high achievement scores in Physics.

The results of the study revealed some scientific conceptions and some alternative conceptions, including inaccurate notions that were resistant to change. So, misconceptions about the phases of the Moon remained, but instruction did result in improvement.

The findings showed that students demonstrated significant improvement in the post-test after receiving constructivist instruction using astronomical models in the targeted Physics concepts in their understanding and learning of these concepts.

The study revealed that Astronomical models have improved students' attitudes in Physics. The study also revealed that students have misconceptions about the solar eclipse, lunar eclipse and phases of the moon. Astronomical models encouraged students to make their own observations and figure out explanations which made understanding easier.

Conclusions

The study revealed that the use of the astronomical models in teaching has improved students' attitudes and achievements in Physics at Komenda College of Education. Thus, misconceptions were eliminated and their attitudes towards Physics became positive. The use of astronomical models is a constructivist approach to teaching.

The use of the astronomical models had proven to be effective approach in teaching Physics at Komenda College of Education and also improved students' attitudes and achievements in Physics. Within the limitations of the study, the interventional instruments designed to improve upon students' attitudes and achievements in Physics yielded positive results. The study showed that for students learn more when they manipulate physical materials, as well as discoveries made for them, help in retention of important information. The finding that the use of the astronomical models is based on constructivist learning theory were more effective than direct instruction is not surprising given the broad evidence that misconceptions in this area are widespread and resistant to change. Traditional method of teaching alone is not up to the task of engaging students in using their mental models to find out where they fail or are inconsistent and to construct new models of the Earth, Sun, and Moon in space.

Also the study showed that students have positive attitudes towards Physics before the introduction of the astronomical models in teaching.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. Physics teachers need to possess not only a detailed and subtle understanding of the subject matter, but also in-depth knowledge of how best to present it in the classroom setting, what is currently called 'pedagogic content knowledge'.
2. Physics teachers should design instructional activities to deal with students' alternative conceptions and to help them understand the accepted scientific concept.
3. By providing students with an environment in which they attempt to explain phenomena through building models that closely approximate it, they are afforded the opportunity to continuously challenge their understandings as they evolve.
4. Student-centered approaches to modelling share common phases which mediate student learning in some successive cycles including exploration, expression, construction, application and revision of models. Especially, researchers emphasize that if students are allowed to build their own mental

representations and present them publicly, it can result in better understanding of the targeted phenomena and processes (Gobert, 2000; Michalchik, Rosenquist, Kozma, Kreikemeier & Schank, 2008).

5. Science teachers and educators are encouraged to utilize models appropriately to foster effective learning of students.

The following recommendations have also been made to the respective group of people based upon the findings and conclusions drawn.

Teachers

Physics teachers must make sure that the subject is given human and affective face. The teacher should make the teaching of Physics very lively by relating it to everyday life situations. Teachers should be aware of the nature of the students, in that teaching approach should now take into consideration the fact that students are holistic learners and to use cooperative learning styles and group work.

Physics teachers should encourage students to love the subject by making sure that their teaching language and teacher student classroom interaction are devoid of gender bias and also by instituting positive reward system like praises when due and phrases that goad them on even in failure: this will help reduce Physics anxiety in the students.

Physics teachers should use the astronomical models in teaching Physics topics for example phases of the moon, the solar system, and eclipses to improve students attitudes and achievements in Physics.

Physics teachers should make use of astronomical models to enhance students understanding of astronomical concepts. Thus, misconceptions of students would be eliminated and their attitudes towards Physics would become positive. Hence, the use of astronomical models is a constructivist approach to teaching.

Suggestions for further research

1. The study should be replicated in other Colleges of Education in Ghana to ascertain the effectiveness of astronomical models.
2. Research should be conducted on how students' ideas change over time.

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APPENDICES

APPENDIX I

Introductory Letter

UNIVERSITY OF EDUCATION, WINNEBA
DEPARTMENT OF SCIENCE EDUCATION
P. O. BOX 25, WINNEBA • TEL: [illegible]

January 25, 2016

Dear Sir/Madam,

TO WHOM IT MAY CONCERN
INTRODUCTORY LETTER

The bearer of this letter, [illegible] with Index Number [illegible] is a Student offering Master of Philosophy in Science Education in the Department of Science Education in the above University.

He is conducting a research on "Using a [illegible] Module to improve Students' Attitudes and Achievements in Physics at Komenda College of Education."

Your college has been selected as his sampling site.

I hope you would assist him to do a good thesis write-up.

Thank you

VICTOR ANTWI, PHD.
Head of Department

VICE PRINCIPAL
KOMENDA COLLEGE
KOMENDA
28/03/16

APPENDIX II

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

M.PHIL (SCIENCE EDUCATION)

USING ASTRONOMICAL MODELS TO IMPROVE STUDENTS ATTITUDES AND ACHIEVEMENTS IN PHYSICS AT KOMENDA COLLEGE OF EDUCATION.

PRE-TEST QUESTION ITEMS

TEST ITEMS BASED ON THE GENERAL SPACE SCIENCE / ASTRONOMY CONCEPTS

This test consists of two sections, A and B. Answer **ALL** the questions in both sections.

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

TIME: 30 MINUTES

1. The phases of the Moon are caused by

A. the rotation of the Earth.

B. the highly elliptical orbit of the Moon.

C. our differing viewing angle of the illuminated half of the Moon.

D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in

A. the discovery that our Universe is expanding.

B. illustrating the need for dark matter in galaxies.

C. discovering planets around other stars.

D. All of these answers.

3. A solar eclipse is caused by

A. the Moon moving directly between the Sun and Earth.

B. the Moon making its closest approach to the Earth.

C. the Earth moving directly between the Sun and Moon.

D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from

A. quasars.

B. the solar nebula.

C. the Big Bang.

D. radio galaxies.

5. Cosmological redshift is the result of the

A. expansion of the universe.

B. super massive black holes.

C. galaxies speeding away from us.

D. Tully-Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in

A. red giants.

B. the Big Bang.

C. supernovae.

D. main sequence stars.

7. The Eclipse which occurs when Moon passes between Earth and the Sun is classified as

A. Star eclipse
B. Ariel eclipse
C. Lunar eclipse
D. Solar eclipse

8.The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. titanic eclipse
C. total eclipse
D. partial eclipse

9.The points at which two orbital planes meet are known as

A. Ariel nodes
B. lunar nodes
C. solar nodes
D. umbra nodes

10. The width of Earths umbra is

A. 3.5 million km

B. 3 million km

C. 1.4 million km

D. 2.5 million km

SECTION B

(10 Marks)

11. Why do solar and lunar eclipses occur?...

……………………………………………………………………………………………

12. What would you recommend the public to do to see the solar eclipse? …………

……………………………………………………………………………………………

13. How long does a solar eclipse last?...

……………………………………………………………………………………………

14. How was the universe made?...

15. What was the Big Bang?..

APPENDIX III

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

M.PHIL (SCIENCE EDUCATION)

USING ASTRONOMICAL MODELS TO IMPROVE STUDENTS ATTITUDES AND ACHIEVEMENTS IN PHYSICS AT KOMENDA COLLEGE OF EDUCATION.

POST-TEST QUESTION ITEMS

TEST ITEMS BASED ON THE GENERAL SPACE SCIENCE / ASTRONOMY CONCEPTS

This test consists of two sections, A and B. Answer **ALL** the questions in both sections.

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

TIME: 30 MINUTES

1. The phases of the Moon are caused by

A. the rotation of the Earth.

B. the highly elliptical orbit of the Moon.

C. our differing viewing angle of the illuminated half of the Moon.

D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

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F. Ariel eclipse

G. Lunar eclipse

H. Solar eclipse

8.The kind of eclipse in which Moon blocks out the Sun entirely is classified as

E. annular eclipse
F. titanic eclipse
G. total eclipse
H. partial eclipse

9.The points at which two orbital planes meet are known as

E. Ariel nodes
F. lunar nodes
G. solar nodes
H. umbra nodes

10. The width of Earths umbra is

E. 3.5 million km
F. 3 million km
G. 1.4 million km
H. 2.5 million km

SECTION B

(10 Marks)

11. Why do solar and lunar eclipses occur?..

………………………………………………………………………………………

12. What would you recommend the public to do to see the solar eclipse? ………

………………………………………………………………………………………

13. How long does a solar eclipse last?...

………………………………………………………………………………………

14. How was the universe made?...

15. What was the Big Bang?..

APPENDIX IV

MARKING SCHEME FOR PRE-TEST QUESTION ITEMS

1. C
2. A
3. A
4. C
5. A
6. B
7. D
8. C
9. B
10. C

QUESTIONS 1-10 = 1 mark each × 10 = (10 marks)

11. Eclipses are caused by the blockage of sunlight. In a lunar eclipse, the Moon "hides" behind the Earth and hence receives (virtually) no sunlight, and thus even when the Moon is supposed to be full we on Earth can't see the whole of it. For solar eclipse, the Moon is directly between the Sun and the Earth, and a simple experiment with a small circular ball will show you that the light emitted cannot reach your eyes. For this reason, solar eclipses can only take place on the first day of each lunar month (synodic month) and lunar eclipses near the fifteenth day of the lunar month. Technically speaking, solar eclipses should be termed

"occultation of the Sun by the Moon", as the Sun does not cease to emit light during solar eclipses.

(2 Marks)

12. A solar eclipse is a great event for anyone to watch because you don't need a telescope to view it. First, always remember to be safe and **NEVER** look at the Sun directly. You can purchase eclipse glasses that have a solar filter that makes it safe to look at the Sun. Alternatively, you can make a very simple pinhole projector by making a small hole in one piece of paper and looking at the projection of the Sun as the light passes through the hole onto another sheet of paper. Even a colander or a leafy tree will make projections of the Sun that anyone can enjoy. **(2 Marks)**

13. The entire disk of the moon (half a degree) has to move across the entire disk of the sun (half a degree), so the moon has to move one degree with respect to the sun between the start and end of the eclipse. One degree is 1/360 of the way around a circle and therefore 1/360 of the moon's orbit around the earth. 1/360 of one month is on the order of a couple hours.

(2 Marks)

14. Many scientists believe that the universe is the result of an explosion called the Big Bang which occurred about 14 billion years ago.

(2 Marks)

15. The Big Bang was an explosion of all the matter in the universe, which was squashed into a tiny area at more 10 billion degree Celsius. The matter exploded so quickly that within the hundredth of a second, the universe was as big as the sun. **(2 Marks)**

TOTAL MARKS = 20 MARKS

APPENDIX V

MARKING SCHEME FOR POST-TEST QUESTION ITEMS

1. C
2. A
3. A
4. C
5. A
6. B
7. D
8. C
9. B
10. C

QUESTIONS 1-10 = 1 mark each × 10 = (10 marks)

11. Eclipses are caused by the blockage of sunlight. In a lunar eclipse, the Moon "hides" behind the Earth and hence receives (virtually) no sunlight, and thus even when the Moon is supposed to be full we on Earth can't see the whole of it. For solar eclipse, the Moon is directly between the Sun and the Earth, and a simple experiment with a small circular ball will show you that the light emitted cannot reach your eyes. For this reason, solar eclipses can only take place on the first day of each lunar month (synodic month) and lunar eclipses near the fifteenth day of the lunar month. Technically speaking, solar eclipses should be termed "occultation of the Sun by the Moon", as the Sun does not cease to emit light during solar eclipses.

(2 Marks)

12. A solar eclipse is a great event for anyone to watch because you don't need a telescope to view it. First, always remember to be safe and **NEVER** look at the

Sun directly. You can purchase eclipse glasses that have a solar filter that makes it safe to look at the Sun. Alternatively, you can make a very simple pinhole projector by making a small hole in one piece of paper and looking at the projection of the Sun as the light passes through the hole onto another sheet of paper. Even a colander or a leafy tree will make projections of the Sun that anyone can enjoy. **(2 Marks)**

13. The entire disk of the moon (half a degree) has to move across the entire disk of the sun (half a degree), so the moon has to move one degree with respect to the sun between the start and end of the eclipse. One degree is 1/360 of the way around a circle and therefore 1/360 of the moon's orbit around the earth. 1/360 of one month is on the order of a couple hours.

    (2 Marks)

14. Many scientists believe that the universe is the result of an explosion called the Big Bang which occurred about 14 billion years ago.

    (2 Marks)

15. The Big Bang was an explosion of all the matter in the universe, which was squashed into a tiny area at more 10 billion degree Celsius. The matter exploded so quickly that within the hundredth of a second, the universe was as big as the sun. **(2 Marks)**

TOTAL MARKS = 20 MARKS

APPENDIX VI

SAMPLES OF STUDENTS RESPONSES TO PRE-TEST QUESTION ITEMS

Sample 1

F-21

PRE-TEST

This test consists of two sections, A and B. Answer ALL the questions in both sections.

SECTION A

(10 Marks)

For questions 1 to 15, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   A. the rotation of the Earth.
   B. the highly elliptical orbit of the Moon.
   C. our differing viewing angle of the illuminated half of the Moon.
   D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   A. the discovery that our Universe is expanding.
   B. illustrating the need for dark matter in galaxies.
   C. discovering planets around other stars.
   D. All of these answers.

3. A solar eclipse is caused by
   A. the Moon moving directly between the Sun and Earth.
   B. the Moon making its closest approach to the Earth.
   C. the Earth moving directly between the Sun and Moon.
   D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   A. quasars.
   B. the solar corona.
   C. the Big Bang.
   D. other galaxies.

5. Cosmological redshift is the result of the
   A. expansion of the universe.
   B. super massive black holes.
   C. galaxies speeding away from us.
   D. Tully Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in
   A. red giants.
   B. the Big Bang.
   C. supernovae.
   D. main sequence stars.

7. The eclipse which occurs when Moon moves between Earth and the sun is described as

A. Solar eclipse

B. [illegible]

C. lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. titanic eclipse
C. total eclipse
D. partial eclipse

9. The points at which two orbital planes meet are known as

A. Attic nodes
B. lunar nodes
C. solar nodes
D. lunation nodes

10. The width of Earths umbra is

A. 8.5 million km
B. 3 million km
C. 1.4 million km
D. 2.5 million km

SECTION B
(10 Marks)

11. Why do solar and lunar eclipses occur? ...the climate change in seasons time and the exchange of day and night

12. What would you recommend the public to do to see the solar eclipse? ...Many ... a dark polythene or eclipse shades

13. How long does a solar eclipse last? ....
5 - 10 minutes

14. How was the universe [illegible]? ...It was created by God

15. Why was the [illegible] being ... [illegible] used to [illegible]

Sample 2

04 (6) 03/03/2016

M-21

PRE-TEST

This test consists of two sections, A and B. Answer ALL the questions in both sections.

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   - A. the rotation of the Earth.
   - B. the highly elliptical orbit of the Moon.
   - C. our differing viewing angle of the illuminated half of the Moon.
   - D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   - A. the discovery that our Universe is expanding.
   - B. illustrating the need for dark matter in galaxies.
   - C. discovering planets around other stars.
   - D. All of these answers.

3. A solar eclipse is caused by
   - A. the Moon moving directly between the Sun and Earth.
   - B. the Moon making its closest approach to the Earth.
   - C. the Earth moving directly between the Sun and Moon.
   - D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   - A. quasars.
   - B. the solar nebula.
   - C. the Big Bang.
   - D. radio galaxies.

5. Cosmological redshift is the result of the
   - A. expansion of the universe.
   - B. super massive black holes.
   - C. galaxies speeding away from us.
   - D. Tully Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in
   - A. red giants.
   - B. the Big Bang.
   - C. supernovae.
   - D. main sequence stars.

7. The Eclipse which occurs when Moon moves between Earth and the Sun is classified as
   - A. [illegible]
   - B. [illegible]

C. Lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. lunar eclipse
C. total eclipse
D. partial eclipse

9. The points at which two orbital planes meet are known as

A. Axial nodes
B. lunar nodes
C. solar nodes
D. umbra nodes

10. The width of Earth's umbra is

A. 3.5 million km
B. 3 million km
C. 1.1 million km
D. 2.5 million km

SECTION B
(10 Marks)

11. Why do we see total lunar eclipses once in... They occur as the results from rotation of moon around the Earth and the rotation of the sun ......

12. What would you recommend the public to do to see the solar eclipse? ...They should... eclipse... always ... during the brightest day...

13. How long does a solar eclipse last? ...It last within the short possible time......

14. How was the universe made? ...They exist as ......

15. What are the Earth? ...It is part of the universe...

Sample 3

[illegible] ALL the questions in this section

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   A. the rotation of the Earth.
   B. the highly elliptical orbit of the Moon.
   C. the differing viewing angle of the illuminated side of the Moon.
   (D) the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   A. the discovery that the Universe is expanding.
   B. illustrating the need for dark matter in galaxies.
   C. discovering planets around other stars.
   (D) All of these answers.

3. A solar eclipse is caused by
   (A) the Moon moving directly between the Sun and Earth.
   B. the Moon making its closest approach to the Earth.
   C. the Earth moving directly between the Sun and Moon.
   D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   A. quasars.
   B. the solar nebula.
   C. the Big Bang.
   (D) radio galaxies.

5. Cosmological redshift is the result of the
   A. expansion of the universe.
   B. super massive black holes.
   (C) galaxies speeding away from us.
   D. Tully-Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in
   A. red giants.
   B. the Big Bang.
   (C) supernovae.
   D. main sequence stars.

7. The Eclipse which occurs when Moon passes between Earth and the Sun is classified as

   A. Star eclipse
   B. Arial eclipse

C. Lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. blanic eclipse
C. total eclipse
D. partial eclipse

9. The points at which two orbital planes meet are known as

A. Aniel nodes
B. lunar nodes
C. solar nodes
D. umbra nodes

10. The width of Earths umbra is

A. 3.5 million km
B. 3 million km
C. 1.4 million km
D. 2.5 million km

SECTION B
(10 Marks)

11. Why do solar and lunar eclipses occur? [illegible]

12. What would you recommend the public to do to see the solar eclipse? they should put on a dark spectacles which will prevent the sun...

13. How long does a solar eclipse last? it last for 10-15 seconds

14. How was the universe made? the universe was made by nature

15. Who was the Big Bang?

Sample 4

PRE-TEST

[illegible]

SECTION A

(10 Marks)

For questions 1 to 10, each item is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   A. the rotation of the Earth.
   B. the highly elliptical orbit of the Moon.
   C. our differing viewing angle of the illuminated half of the Moon.
   D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   A. the discovery that our Universe is expanding.
   B. illustrating the need for dark matter in galaxies.
   C. discovering planets around other stars.
   D. All of these answers.

3. A solar eclipse is caused by
   A. the Moon moving directly between the Sun and Earth.
   B. the Moon making its closest approach to the Earth.
   C. the Earth moving directly between the Sun and Moon.
   D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   A. quasars.
   B. the solar nebula.
   C. the Big Bang.
   D. radio galaxies.

5. Cosmological redshift is the result of the
   A. expansion of the universe.
   B. super massive black holes.
   C. galaxies speeding away from us.
   D. Tully-Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in
   A. red giants.
   B. the Big Bang.
   C. supernovae.
   D. main sequence stars.

7. The Eclipse which occurs when Moon passes between Earth and the Sun is classified as

   A. Star eclipse
   B. Axial eclipse

C. Lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. lunar eclipse
C. total eclipse
D. partial eclipse

9. The points at which two orbital planes meet are known as

A. Axial nodes
B. lunar nodes
C. solar nodes
D. umbra nodes

10. The width of Earth's umbra is

A. 3.5 million km
B. 3 million km
C. 1.4 million km
D. 2.5 million km

SECTION B
(10 Marks)

11. Why do solar and lunar eclipses occur? It occur due to the rotation of the moon and the earth

12. What would you recommend the public to do to see the solar eclipse? I will recommend the public to wear solar eclipse glasses to protect the eye

13. How long does a solar eclipse last? Total eclipse last for 3 minute and partial last for about several minute

14. How was the universe made? The universe is made up of the flames

15. What was the Big Bang ....

Sample 5

③ M-23

[illegible]

[illegible] Answer ALL the questions [illegible]

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   Ⓐ the rotation of the Earth.
   B. the highly elliptical orbit of the Moon
   C. our differing viewing angle of the illuminated half of the Moon
   D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   A. the discovery that our Universe is expanding.
   B. illustrating the need for dark matter in galaxies
   C. discovering planets around other stars.
   Ⓓ All of these answers.

3. A solar eclipse is caused by
   Ⓐ the Moon moving directly between the Sun and Earth
   B. the Moon making its closest approach to the Earth
   C. the Earth moving directly between the Sun and Moon
   D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   A. quasars.
   B. the solar nebula.
   Ⓒ the Big Bang.
   D. radio galaxies.

5. Cosmological redshift is the result of the
   A. expansion of the universe
   B. super massive black holes
   Ⓒ galaxies speeding away from us.
   D. Tully-Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in
   Ⓐ red giants.
   B. the Big Bang.
   C. supernovae.
   D. main sequence stars.

7. The Eclipse which occurs when Moon passes between Earth and the Sun is classified as

   A. Star eclipse
   B. Arial eclipse

C. Lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. [illegible] eclipse
C. total eclipse
D. partial eclipse

9. The points at which two orbital planes meet are known as

A. Ariel nodes
B. lunar nodes
C. solar nodes
D. [illegible] nodes

10. The width of Earth's umbra is

A. 2.5 million km
B. 3 million km
C. 1.4 million km
D. 2.5 million km

SECTION B
(10 Marks)

11. Why do solar and lunar eclipses occur?...They occur due to [illegible] [illegible] the moon [illegible] the earth...........

12. What would you recommend the public to do to see the solar eclipse? ....
The use of [illegible]..

13. How long does a total eclipse last? ... It can last for about [illegible] to fifteen [illegible] minutes....................

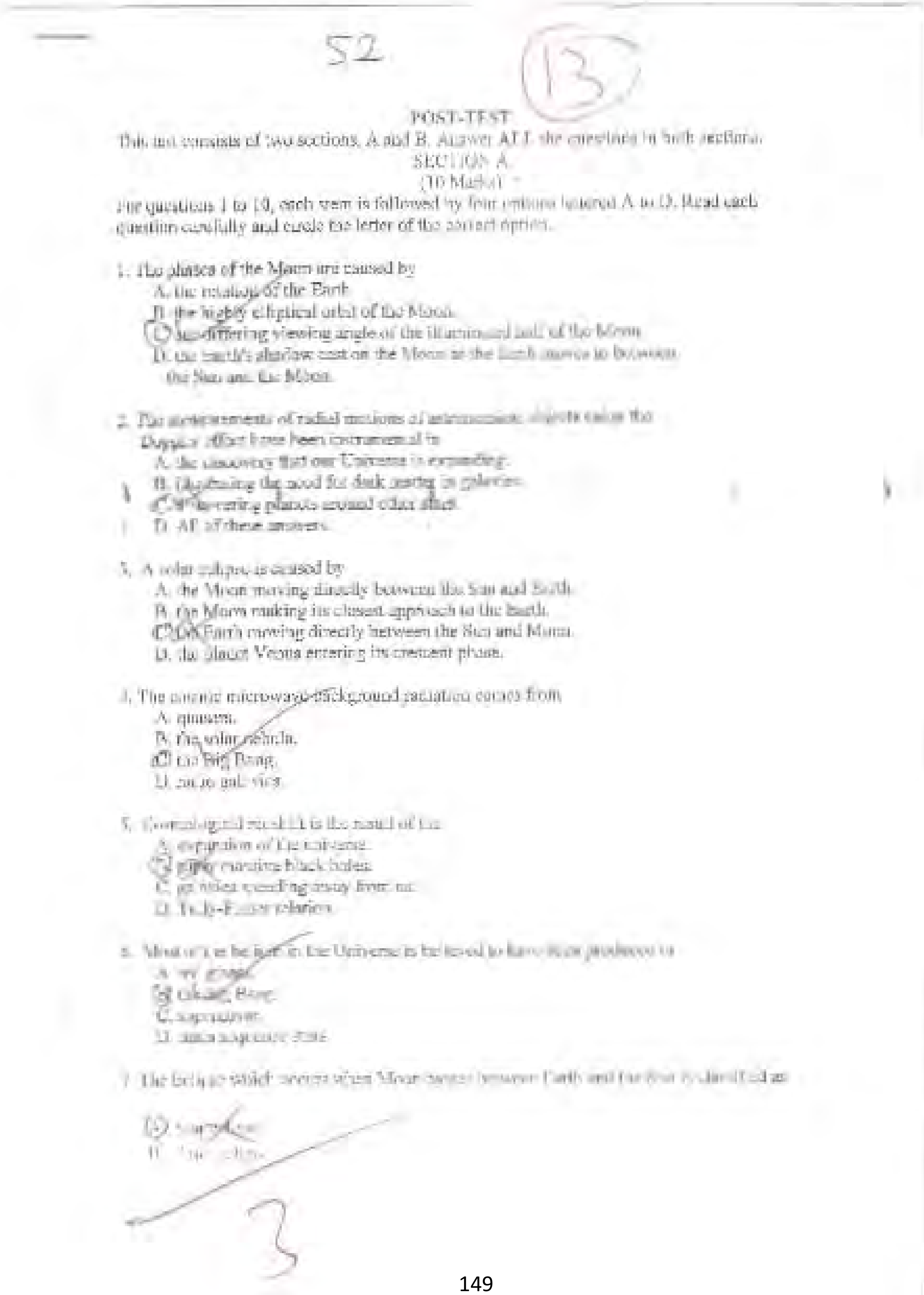
14. How was the [illegible] made? ... It was [illegible] by the [illegible]

15. What was the [illegible] ... It was [illegible] the [illegible] [illegible]

APPENDIX VII

SAMPLES OF STUDENTS' RESPONSES TO POST TEST QUESTION ITEMS

Sample 1



POST-TEST

This test consists of two sections, A and B. Answer ALL the questions in both sections.

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   A. the rotation of the Earth
   B. the highly elliptical orbit of the Moon.
   C. the differing viewing angle of the illuminated half of the Moon
   D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   A. the discovery that our Universe is expanding.
   B. illustrating the need for dark matter in galaxies.
   C. discovering planets around other stars.
   D. All of these answers.

3. A solar eclipse is caused by
   A. the Moon moving directly between the Sun and Earth.
   B. the Moon making its closest approach to the Earth.
   C. the Earth moving directly between the Sun and Moon.
   D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   A. quasars.
   B. the solar nebula.
   C. the Big Bang.
   D. [illegible] galaxies.

5. Cosmological redshift is the result of the
   A. expansion of the universe.
   B. supermassive black holes.
   C. galaxies speeding away from us.
   D. [illegible]

6. Most of the [illegible] in the Universe is believed to have been produced in
   A. [illegible]
   B. the Big Bang.
   C. supernovae.
   D. [illegible]

7. The Eclipse which occurs when Moon passes between Earth and the Sun is classified as
   A. [illegible]
   B. [illegible]

C. Lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. titanic eclipse
C. total eclipse
D. partial eclipse

9. The points at which two orbital planes meet are known as

A. Ariel nodes
B. lunar nodes
C. solar nodes
D. umbra nodes

10. The width of Earth's umbra is

A. 3.5 million km
B. 3 million km
C. 1.4 million km
D. 2.5 million km

SECTION B
(10 Marks)

11. Why do solar and lunar eclipses occur?...

For day and night to occur

12. What would you recommend the public to do to see the solar eclipse?.....................

They should use recommended spectacles

13. How long does a solar eclipse last?...

7 minutes

14. How was the universe made?... Through the big bang

15. What was the big bang? An explosion giving rise to universe

10

Sample 2

POST-TEST

This test consists of two sections, A and B. Answer ALL the questions in both sections.

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   A. the rotation of the Earth.
   B. the highly elliptical orbit of the Moon.
   C. our differing viewing angle of the illuminated half of the Moon.
   D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   A. the discovery that our Universe is expanding
   B. illustrating the need for dark matter in galaxies.
   C. discovering planets around other stars.
   D. All of these answers.

3. A solar eclipse is caused by
   A. the Moon moving directly between the Sun and Earth.
   B. the Moon making its closest approach to the Earth.
   C. the Earth moving directly between the Sun and Moon.
   D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   A. quasars.
   B. the solar nebula.
   C. the Big Bang.
   D. radio galaxies.

5. Cosmological redshift is the result of the
   A. expansion of the universe
   B. supermassive black holes
   C. galaxies speeding away from us.
   D. Tully-Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in
   A. red giants.
   B. the Big Bang.
   C. supernovae.
   D. main sequence stars.

7. The Eclipse which occurs when Moon passes between Earth and the Sun is classified as [illegible]
   A. [illegible]
   B. [illegible]

C. Lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. Hybrid eclipse
C. total eclipse
D. partial eclipse

9. The points at which two orbital planes meet are known as

A. Arial nodes
B. lunar nodes
C. solar nodes
D. umbra nodes

10. The width of Earth's umbra is

A. 3.5 million km
B. 3 million km
C. 1.4 million km
D. 2.5 million km

SECTION B
(10 Marks)

11. Why do solar and lunar eclipses occur? blockage of sunlight (2)

....

12. What would you recommend the public to do to see the solar eclipse? ....
Eclipse glasses / sun shades eclipse (2)

13. How long does a solar eclipse last? ....

....

14. How was the universe made? as a result of explosion (2)

15. What was the Big Bang? was an explosion of all matter in the universe (2)

10

Sample 3

66

18

POST-TEST

This test consists of two sections, A and B. Answer **ALL** the questions in both sections

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   A. the rotation of the Earth.
   B. the highly elliptical orbit of the Moon.
   C. our differing viewing angle of the illuminated half of the Moon.
   D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   A. the discovery that our Universe is expanding.
   B. illustrating the need for dark matter in galaxies.
   C. discovering planets around other stars.
   D. All of these answers.

3. A solar eclipse is caused by
   A. the Moon moving directly between the Sun and Earth.
   B. the Moon making its closest approach to the Earth.
   C. the Earth moving directly between the Sun and Moon.
   D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   A. quasars.
   B. the solar nebula.
   C. the Big Bang.
   D. radio galaxies.

5. Cosmological redshift is the result of the
   A. expansion of the universe.
   B. super massive black holes.
   C. galaxies speeding away from us.
   D. Tully-Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in
   A. red giants.
   B. the Big Bang.
   C. supernovae.
   D. main sequence stars.

7. The Eclipse which occurs when Moon passes between Earth and the Sun is classified as
   A. Sun eclipse
   B. [illegible]

C. Lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. [illegible] eclipse
C. total eclipse
D. partial eclipse

9. The points at which two orbital planes meet are known as

A. Axial nodes
B. lunar nodes
C. solar nodes
D. umbra nodes

10. The width of Earth's umbra is

A. 1.5 million km
B. 3 million km
C. 1.7 million km
D. 1.5 million km

SECTION B
(10 Marks)

11. Why do solar and lunar eclipses occur? blockage of sun light

eclipse glasses/sun shades eclipse

12. What would you recommend the public to use to see the solar eclipse? eclipse glasses/ Sun shade eclipse

13. How long does a solar eclipse last? 5hrs

14. How was the universe made? As a result of explosion

15. What does the Big Bang [illegible] there was an explosion which brought in the universe

10

Sample 4

64 17

POST-TEST

This test consists of two sections, A and B. Answer ALL the questions in both sections.

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   - A. the rotation of the Earth.
   - B. the highly elliptical orbit of the Moon.
   - C. our differing viewing angle of the illuminated half of the Moon.
   - D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   - A. the discovery that our Universe is expanding.
   - B. illustrating the need for dark matter in galaxies.
   - C. discovering planets around other stars.
   - D. All of these answers.

3. A solar eclipse is caused by
   - A. the Moon moving directly between the Sun and Earth.
   - B. the Moon making its closest approach to the Earth.
   - C. the Earth moving directly between the Sun and Moon.
   - D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   - A. quasars.
   - B. the solar nebula.
   - C. the Big Bang.
   - D. radio galaxies.

5. Cosmological redshift is the result of the
   - A. expansion of the universe.
   - B. super massive black holes.
   - C. galaxies speeding away from us.
   - D. Tully-Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in
   - A. red giants.
   - B. the Big Bang.
   - C. supernovae.
   - D. main sequence stars.

7. The Eclipse which occurs when [illegible] between [illegible] and the Sun is classified [illegible]
   - a) [illegible]
   - b) [illegible]

C. Lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. titanic eclipse
C. total eclipse
D. partial eclipse

9. The points at which two orbital planes meet are known as

A. Axial nodes
B. lunar nodes
C. solar nodes
D. umbra nodes

10. The width of Earths umbra is

A. 3.5 million km
B. 3 million km
C. 1.4 million km
D. 2.5 million km

SECTION B
(10 Marks)

11. Why do solar and lunar eclipses occur? ....

....

12. What would you recommend the public to do to see the solar eclipse? ....

....

13. How long does a solar eclipse last? ....

....

14. How was the universe made? ....

15. What was the Big Bang? ....

Sample 5

65

B

POST-TEST

This test consists of two sections, A and B. Answer ALL the questions in both sections.

SECTION A

(10 Marks)

For questions 1 to 10, each stem is followed by four options lettered A to D. Read each question carefully and circle the letter of the correct option.

1. The phases of the Moon are caused by
   A. the rotation of the Earth.
   B. the highly elliptical orbit of the Moon.
   C. our differing viewing angle of the illuminated half of the Moon.
   D. the Earth's shadow cast on the Moon as the Earth moves in between the Sun and the Moon.

2. The measurements of radial motions of astronomical objects using the Doppler effect have been instrumental in
   A. the discovery that our Universe is expanding.
   B. illustrating the need for dark matter in galaxies.
   C. discovering planets around other stars.
   D. All of these answers.

3. A solar eclipse is caused by
   A. the Moon moving directly between the Sun and Earth.
   B. the Moon making its closest approach to the Earth.
   C. the Earth moving directly between the Sun and Moon.
   D. the planet Venus entering its crescent phase.

4. The cosmic microwave background radiation comes from
   A. quasars.
   B. the solar nebula.
   C. the Big Bang.
   D. radio galaxies.

5. Cosmological redshift is the result of the
   A. expansion of the universe.
   B. super massive black holes.
   C. galaxies speeding away from us.
   D. Tully-Fisher relation.

6. Most of the helium in the Universe is believed to have been produced in
   A. red giants.
   B. the Big Bang.
   C. supernovae.
   D. main sequence stars.

7. The Eclipse which occurs when Moon passes between the Earth and the Sun is classified as
   a. [illegible]
   b. [illegible]

C. Lunar eclipse
D. Solar eclipse

8. The kind of eclipse in which Moon blocks out the Sun entirely is classified as

A. annular eclipse
B. [illegible] eclipse
C. total eclipse
D. partial eclipse

9. The point at which two orbital planes meet are known as

A. Axial nodes
B. lunar nodes
C. [illegible] nodes
D. [illegible] nodes

10. The width of Earth's [illegible] is

A. 3.5 million km
B. 5 million km
C. 1.4 million km
D. 2.5 million km

SECTION B
(10 Marks)

11. Why do solar and lunar eclipses occur? blockage of Sunlight

12. What would you recommend the public to do to see the solar eclipse? Eclipse glasses / Sun shades eclipse

13. How long does a solar eclipse last? ~~as a result of explosion~~

14. How was the universe made? as a result of explosion

15. What are the [illegible]? Was an explosion of all matter in the universe

12

APPENDIX VIII

UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

M.PHIL (SCIENCE EDUCATION)

QUESTIONNAIRE FOR STUDENTS ON ATTITUDE TOWARDS PHYSICS SCALE (ATPS).

USING ASTRONOMICAL MODELS TO IMPROVE STUDENTS ATTITUDES AND ACHIEVEMENTS IN PHYSICS AT KOMENDA COLLEGE OF EDUCATION.

Introduction

This questionnaire is strictly for academic purpose and you are assured of its complete anonymity as well as all information provided would be treated with confidentiality. As such you need not write your name on the questionnaire. It is my hope that you will feel free to respond to the questions as frankly as possible.

SECTION A

GENERAL INFORMATION

Please tick in the boxes your sex and provide your age.

A. Sex: i. Male [ ]

ii. Female [ ]

B. Age : (in years) _______________

SECTION B

Please tick in the boxes the extent to which you agree or disagree with the statements about the teaching and learning of Physics in Komenda College of Education.

The options are:

SA= Strongly Agree A = Agree U = Undecided D = Disagree SD= strongly disagree

S/N	ITEMS	SA	A	U	D	SD
1	Physics is useful in our daily lives.					
2	Physics thrills me and I like it better than any subject.					
3	Physics should be made optional in our educational curriculum.					
4	I think Physics is the most enjoyable subject I am offering now.					
5	I think Physics is the most enjoyable subject among the other science subjects.					
6	Physics seems to be more difficult for girls than boys.					
7	Physics runs through all other subjects.					
8	Physics increases my ability to solve real life problems.					
9	Girls like studying Physics more than boys.					
10	I wish Physics is studied without conducting any exams on it.					
11	I enjoy the challenges presented by Physics problems.					
12	Physics increases my ability to think logically.					
13	I always feel uncomfortable when the Physics teacher enters the classroom.					
14	It is useful for girls to learn Physics.					
15	I never get tired in working problems in Physics.					
16	I am always happy to listen to the Physics teacher as he /she teaches					
17	I would have stopped studying Physics if it had been optional.					
18	Parents encourage boys to learn Physics more than girls.					
19	Physics helps me to be systematic, accurate, and objective.					
20	I am interested in solving difficult problems in Physics.					
21	Boys need Physics in life more than girls.					
22	Boys have the natural ability to study Physics than girls.					
23	Physics is a subject meant to punish students.					
24	Physics is a subject meant to punish girls.					
25	I do not like Physics because I know it will spoil my grades.					
26	I think Physics is more important than all other subjects.					
27	I am afraid of Physics examinations.					
28	Physics is more of a threat to educational success.					

APPENDIX IX

INTERVIEW PROTOCOL FOR STUDENTS BASED ON GENERAL SPACE SCIENCE AND ASTRONOMY CONCEPTS

TIME: 20-30 MINUTES

Basic astronomy concepts

(1) What is the shape of the Earth and the Moon? Why does the Earth have day and night?

(2) How long does the Earth take to go around the Sun?

General space science/astronomy concepts

(3) Can you tell me what causes the phases of the Moon?

(4) (a) Can you show me the position of the Sun, Earth and Moon for a lunar eclipse to occur?

(b) How about a solar eclipse?

(5) (a) What is the difference between a lunar eclipse and a new moon?

(b) What is the difference between a solar eclipse and a full Moon?

APPENDIX X

Case Summaries of Data[a]

	GROUP	TEST	SEX OF STUDENTS	AGE OF STUDENTS	TEST SCORE	QUESTION 1	QUESTION 2	QUESTION 3	QUESTION 4	QUESTION 5	QUESTION 6	QUESTION 7	QUESTION 8	QUESTION 9	QUESTION 10
1	EXPERIMENTAL GROUP	PRE TEST	FEMALE	20.00	5.00	D	D	A	D	C	C	D	C	A	A
2	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	5.00	C	C	A	D	A	A	D	C	D	D
3	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	8.00	A	D	A	C	C	A	D	C	A	A
4	EXPERIMENTAL GROUP	PRE TEST	FEMALE	22.00	11.00	D	B	A	D	C	B	C	C	A	D
5	EXPERIMENTAL GROUP	PRE TEST	MALE	25.00	6.00	B	C	D	A	A	A	D	C	A	A
6	EXPERIMENTAL GROUP	PRE TEST	MALE	21.00	4.00	A	B	A	D	C	B	D	C	A	A
7	EXPERIMENTAL GROUP	PRE TEST	FEMALE	20.00	6.00	D	C	A	D	C	B	D	C	D	A
8	EXPERIMENTAL GROUP	PRE TEST	FEMALE	21.00	3.00	A	D	C	D	A	D	C	D	D	A
9	EXPERIMENTAL GROUP	PRE TEST	MALE	22.00	6.00	A	C	A	C	A	C	D	C	A	C
10	EXPERIMENTAL GROUP	PRE TEST	MALE	22.00	7.00	C	C	A	D	C	B	D	C	D	A
11	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	6.00	A	B	B	C	B	C	A	C	B	C
12	EXPERIMENTAL GROUP	PRE TEST	MALE	21.00	7.00	B	C	A	C	A	D	C	C	D	D
13	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	6.00	C	D	D	A	A	B	D	D	B	C
14	EXPERIMENTAL GROUP	PRE TEST	FEMALE	22.00	7.00	A	A	A	B	A	B	D	C	D	C

15	EXPERIMENTAL GROUP	PRE TEST	FEMALE	20.00	3.00	C	D	A	B	C	C	C	C	D	A
16	EXPERIMENTAL GROUP	PRE TEST	FEMALE	21.00	8.00	C	A	A	B	A	D	D	C	D	A
17	EXPERIMENTAL GROUP	PRE TEST	MALE	21.00	5.00	D	A	B	C	A	A	C	C	A	A
18	EXPERIMENTAL GROUP	PRE TEST	MALE	21.00	7.00	D	C	A	A	B	B	A	C	D	C
19	EXPERIMENTAL GROUP	PRE TEST	MALE	21.00	7.00	B	B	A	B	D	C	C	C	D	C
20	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	4.00	B	B	A	C	C	B	C	C	A	A
21	EXPERIMENTAL GROUP	PRE TEST	MALE	24.00	10.00	D	A	A	B	A	A	D	C	B	B
22	EXPERIMENTAL GROUP	PRE TEST	MALE	24.00	3.00	D	B	A	D	C	A	C	C	A	C
23	EXPERIMENTAL GROUP	PRE TEST	FEMALE	23.00	4.00	D	C	A	D	B	B	D	C	C	B
24	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	5.00	B	C	A	D	A	B	D	C	A	A
25	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	6.00	C	D	A	D	B	A	D	C	A	A
26	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	9.00	D	A	A	B	C	C	D	C	A	C
27	EXPERIMENTAL GROUP	PRE TEST	FEMALE	24.00	6.00	B	C	A	C	C	B	D	C	D	D
28	EXPERIMENTAL GROUP	PRE TEST	MALE	24.00	2.00	D	B	A	B	B	A	C	C	A	A
29	EXPERIMENTAL GROUP	PRE TEST	FEMALE	22.00	6.00	D	D	C	D	C	D	C	C	A	A
30	EXPERIMENTAL GROUP	PRE TEST	FEMALE	23.00	3.00	A	C	C	C	C	B	C	C	A	B
31	EXPERIMENTAL GROUP	PRE TEST	FEMALE	24.00	9.00	B	C	A	D	A	B	D	C	A	A

32	EXPERIMENTAL GROUP	PRE TEST	MALE	27.00	3.00	A	C	A	C	B	D	C	C	D	A
33	EXPERIMENTAL GROUP	PRE TEST	FEMALE	25.00	4.00	B	B	C	B	C	B	C	C	A	A
34	EXPERIMENTAL GROUP	PRE TEST	MALE	22.00	8.00	D	B	C	C	C	C	D	C	C	C
35	EXPERIMENTAL GROUP	PRE TEST	FEMALE	23.00	5.00	A	A	A	C	A	B	B	A	A	A
36	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	3.00	A	C	C	D	C	B	C	A	D	A
37	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	5.00	A	C	A	D	C	B	B	B	C	C
38	EXPERIMENTAL GROUP	PRE TEST	MALE	25.00	6.00	A	A	A	C	C	B	C	C	B	A
39	EXPERIMENTAL GROUP	PRE TEST	MALE	23.00	4.00	A	C	A	B	C	A	D	C	B	A
40	EXPERIMENTAL GROUP	PRE TEST	MALE	21.00	3.00	A	D	C	C	A	B	C	D	D	D
41	EXPERIMENTAL GROUP	POST TEST	FEMALE	20.00	13.00	C	D	A	C	B	C	D	C	B	C
42	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	10.00	C	A	A	C	A	B	D	C	B	C
43	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	18.00	C	A	A	C	A	B	D	C	B	C
44	EXPERIMENTAL GROUP	POST TEST	FEMALE	22.00	10.00	D	C	A	C	A	D	D	C	A	C
45	EXPERIMENTAL GROUP	POST TEST	MALE	25.00	8.00	A	D	A	A	A	A	D	C	D	B
46	EXPERIMENTAL GROUP	POST TEST	MALE	21.00	8.00	A	C	A	C	C	B	D	C	A	A
47	EXPERIMENTAL GROUP	POST TEST	FEMALE	20.00	6.00	D	C	C	C	D	A	C	C	A	D
48	EXPERIMENTAL GROUP	POST TEST	FEMALE	21.00	6.00	D	C	A	B	A	D	D	C	A	C

49	EXPERIMENTAL GROUP	POST TEST	MALE	22.00	8.00	A	C	A	B	A	D	D	C	A	C
50	EXPERIMENTAL GROUP	POST TEST	MALE	22.00	13.00	A	C	C	C	A	A	D	C	A	C
51	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	5.00	D	D	A	C	B	B	D	C	D	B
52	EXPERIMENTAL GROUP	POST TEST	MALE	21.00	13.00	C	C	C	C	B	B	A	C	A	C
53	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	10.00	A	C	A	C	B	B	D	C	D	A
54	EXPERIMENTAL GROUP	POST TEST	FEMALE	22.00	5.00	D	D	A	D	A	B	C	C	A	A
55	EXPERIMENTAL GROUP	POST TEST	FEMALE	20.00	1.00	D	D	D	D	D	D	D	D	D	D
56	EXPERIMENTAL GROUP	POST TEST	FEMALE	21.00	2.00	A	B	C	C	C	B	C	B	C	B
57	EXPERIMENTAL GROUP	POST TEST	MALE	21.00	18.00	C	A	A	C	A	B	D	C	B	C
58	EXPERIMENTAL GROUP	POST TEST	MALE	21.00	4.00	A	D	A	D	C	D	C	C	A	D
59	EXPERIMENTAL GROUP	POST TEST	MALE	21.00	18.00	C	A	A	C	A	B	D	C	B	C
60	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	6.00	A	D	C	A	A	B	D	A	C	C
61	EXPERIMENTAL GROUP	POST TEST	MALE	24.00	3.00	D	C	A	B	B	A	A	C	C	A
62	EXPERIMENTAL GROUP	POST TEST	MALE	24.00	11.00	D	C	A	B	A	D	D	C	A	C
63	EXPERIMENTAL GROUP	POST TEST	FEMALE	23.00	18.00	C	A	A	C	A	B	D	C	B	C
64	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	17.00	C	A	B	C	A	B	D	C	B	C
65	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	18.00	C	A	A	C	A	B	B	C	B	C

66	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	16.00	C	A	A	C	A	B	C	C	B	D
67	EXPERIMENTAL GROUP	POST TEST	FEMALE	24.00	18.00	C	A	A	C	A	B	D	C	B	C
68	EXPERIMENTAL GROUP	POST TEST	MALE	24.00	18.00	C	A	A	C	A	B	D	C	B	C
69	EXPERIMENTAL GROUP	POST TEST	FEMALE	22.00	9.00	C	C	A	B	C	B	D	C	A	A
70	EXPERIMENTAL GROUP	POST TEST	FEMALE	23.00	16.00	C	A	A	C	C	C	D	C	B	C
71	EXPERIMENTAL GROUP	POST TEST	FEMALE	24.00	17.00	C	A	A	C	A	B	D	C	D	C
72	EXPERIMENTAL GROUP	POST TEST	MALE	27.00	16.00	C	A	A	C	A	B	C	D	B	C
73	EXPERIMENTAL GROUP	POST TEST	FEMALE	25.00	18.00	C	A	A	C	A	B	D	C	B	C
74	EXPERIMENTAL GROUP	POST TEST	MALE	22.00	18.00	C	A	A	C	A	B	D	C	B	C
75	EXPERIMENTAL GROUP	POST TEST	FEMALE	23.00	18.00	C	A	A	C	A	B	D	C	B	C
76	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	15.00	B	A	A	C	A	B	C	B	B	C
77	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	12.00	C	A	A	C	B	D	C	B	A	A
78	EXPERIMENTAL GROUP	POST TEST	MALE	25.00	16.00	A	A	A	C	A	B	D	C	A	C
79	EXPERIMENTAL GROUP	POST TEST	MALE	23.00	18.00	C	A	A	C	A	B	D	C	B	C
80	EXPERIMENTAL GROUP	POST TEST	MALE	21.00	16.00	C	A	A	C	A	D	D	C	B	C
Total	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80

Survey data, 2016

a. Limited to first 100 cases.

APPENDIX XI

Attitude Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ATTITUDE SCORE	40	48.00	122.00	89.485	15.63912
Valid N (listwise)	40				

Group Statistics

	SEX	N	Mean	Std. Deviation	Std. Error Mean
ATTITUDE	MALE	26	92.3462	14.18074	1.96652
SCORE	FEMAE	14	84.1786	17.05341	3.22279

APPENDIX XII

Independent Sample Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ATTITUDE SCORE	Equal variances assumed	1.273	.263	2.287	38	.025	8.16758	3.57150	1.05727	15.27789
	Equal variances not assumed			2.163	27.372	.036	8.16758	3.77539	.57405	15.76111

Group Statistics

	TEST	N	Mean	Std. Deviation	Std. Error Mean
ATTITUDE	PRE TEST	40	86.8500	15.82849	2.50270
SCORE	POST TEST	40	92.1250	15.18634	2.40117

APPENDIX XIII

Independent Sample Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
ATTITUDE SCORE	Equal variances assumed	.021	.885	-1.521	38	.132	-5.27500	3.46831	-12.17987	1.62987
	Equal variances not assumed			-1.521	27.867	.132	-5.27500	3.46831	-12.18005	1.63005

APPENDIX XIV

Descriptive Statistics

	N	Min	Max	Mean	SD
QUESTION 1	40	3.00	5.00	4.4750	.61572
QUESTION 2	40	1.00	5.00	2.9500	1.18962
QUESTION 3	40	1.00	5.00	2.7000	1.45306
QUESTION 4	40	1.00	5.00	2.6250	1.26666
QUESTION 5	40	1.00	5.00	2.7750	1.27264
QUESTION 6	40	1.00	5.00	2.3125	1.23856
QUESTION 7	40	1.00	5.00	3.2750	1.29238
QUESTION 8	40	1.00	5.00	3.7625	1.12783
QUESTION 9	40	1.00	5.00	1.8500	.92913
QUESTION 10	40	1.00	5.00	3.2625	1.49042
QUESTION 11	40	1.00	5.00	3.1875	1.29355
QUESTION 12	40	1.00	5.00	4.0250	1.12481
QUESTION 13	40	1.00	5.00	3.1750	1.39416
QUESTION 14	40	1.00	5.00	3.9375	1.11768
QUESTION 15	40	1.00	5.00	2.9625	1.27730
QUESTION 16	40	1.00	5.00	3.2250	1.40501
QUESTION 17	40	1.00	5.00	3.2875	1.49424
QUESTION 18	40	1.00	5.00	2.4250	1.21983
QUESTION 19	40	1.00	5.00	3.9250	1.16679
QUESTION 20	40	1.00	5.00	3.2500	1.37334
QUESTION 21	40	1.00	5.00	2.1875	1.12614
QUESTION 22	40	1.00	5.00	2.6875	1.38339
QUESTION 23	40	1.00	5.00	4.1125	1.11371
QUESTION 24	40	1.00	5.00	4.1750	1.06468
QUESTION 25	40	1.00	5.00	3.6250	1.29629
QUESTION 26	40	1.00	5.00	2.4375	1.15664
QUESTION 27	40	1.00	5.00	3.3375	1.29208
QUESTION 28	40	1.00	5.00	3.5375	1.34017
Valid N (listwise)	40				

APPENDIX XV

Attitude

Pre-test Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
QUESTION 1	40	3.00	5.00	4.3500	.66216
QUESTION 2	40	1.00	5.00	2.6750	1.09515
QUESTION 3	40	1.00	5.00	2.6500	1.45972
QUESTION 4	40	1.00	5.00	2.4750	1.32021
QUESTION 5	40	1.00	5.00	2.7500	1.19293
QUESTION 6	40	1.00	5.00	2.3750	1.29471
QUESTION 7	40	1.00	5.00	2.9750	1.25038
QUESTION 8	40	1.00	5.00	3.5000	1.17670
QUESTION 9	40	1.00	5.00	1.8750	1.01748
QUESTION 10	40	1.00	5.00	3.3000	1.36250
QUESTION 11	40	1.00	5.00	2.8500	1.23101
QUESTION 12	40	1.00	5.00	3.9250	1.14102
QUESTION 13	40	1.00	5.00	3.1000	1.41058
QUESTION 14	40	1.00	5.00	3.8000	1.18105
QUESTION 15	40	1.00	5.00	2.8750	1.30458
QUESTION 16	40	1.00	5.00	3.0250	1.44093
QUESTION 17	40	1.00	5.00	3.2750	1.46738
QUESTION 18	40	1.00	5.00	2.5250	1.21924
QUESTION 19	40	1.00	5.00	3.6250	1.23387
QUESTION 20	40	1.00	5.00	3.0000	1.32045
QUESTION 21	40	1.00	5.00	2.5000	1.21950
QUESTION 22	40	1.00	5.00	2.9250	1.36603
QUESTION 23	40	1.00	5.00	3.9250	1.16327
QUESTION 24	40	1.00	5.00	3.9750	1.16548
QUESTION 25	40	1.00	5.00	3.5500	1.23931
QUESTION 26	40	1.00	5.00	2.5750	1.17424
QUESTION 27	40	1.00	5.00	3.3000	1.32433
QUESTION 28	40	1.00	5.00	3.1750	1.25856
Valid N (listwise)	40				

APPENDIX XVI

Attitude

Post-test Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
QUESTION 1	40	3.00	5.00	4.6000	.54538
QUESTION 2	40	1.00	5.00	3.2250	1.22971
QUESTION 3	40	1.00	5.00	2.7500	1.46322
QUESTION 4	40	1.00	5.00	2.7750	1.20868
QUESTION 5	40	1.00	5.00	2.8000	1.36250
QUESTION 6	40	1.00	5.00	2.2500	1.19293
QUESTION 7	40	1.00	5.00	3.5750	1.27877
QUESTION 8	40	1.00	5.00	4.0250	1.02501
QUESTION 9	40	1.00	4.00	1.8250	.84391
QUESTION 10	40	1.00	5.00	3.2250	1.62493
QUESTION 11	40	1.00	5.00	3.5250	1.28078
QUESTION 12	40	1.00	5.00	4.1250	1.11373
QUESTION 13	40	1.00	5.00	3.2500	1.39137
QUESTION 14	40	1.00	5.00	4.0750	1.04728
QUESTION 15	40	1.00	5.00	3.0500	1.25983
QUESTION 16	40	1.00	5.00	3.4250	1.35661
QUESTION 17	40	1.00	5.00	3.3000	1.53923
QUESTION 18	40	1.00	5.00	2.3250	1.22762
QUESTION 19	40	1.00	5.00	4.2250	1.02501
QUESTION 20	40	1.00	5.00	3.5000	1.39596
QUESTION 21	40	1.00	5.00	1.8750	.93883
QUESTION 22	40	1.00	5.00	2.4500	1.37654
QUESTION 23	40	1.00	5.00	4.3000	1.04268
QUESTION 24	40	1.00	5.00	4.3750	.92508
QUESTION 25	40	1.00	5.00	3.7000	1.36250
QUESTION 26	40	1.00	5.00	2.3000	1.13680
QUESTION 27	40	1.00	5.00	3.3750	1.27475
QUESTION 28	40	1.00	5.00	3.9000	1.33589
Valid N (listwise)	40				